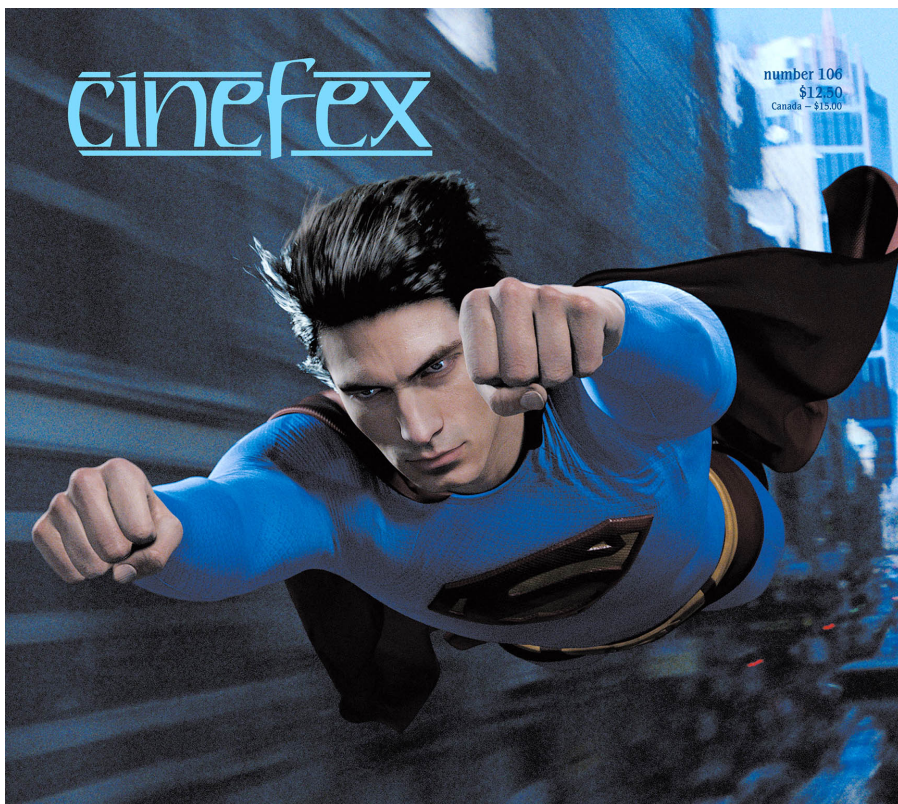


cinefex

number 106
\$12.50
Canada - \$15.00



PUBLISHER
Don Shay

EDITOR
Jody Duncan

ASSOCIATE EDITOR
Joe Fordham

ASSISTANT EDITOR
Estelle Shay

DESIGN CONSULTANT
Michael Gross

ADVERTISING DIRECTOR
Bill Lindsay

ADVERTISING REPRESENTATIVES
Janice Hubbard Lindsay
Bernice Briggs
Arlene Hansen

PRODUCTION MANAGER
Margie Duncan

WEBMASTER
Gregg Shay

PRINTED IN USA
CINEFEX 106 - JULY 2006
CINEFEX is published quarterly at P.O. Box 20027, Riverside, CA
92516. Tel: 951-781-1917 Fax: 951-788-1793 URL: www.cinefex.com.
E-mail: letters@cinefex.com / editorial@cinefex.com / advertising@
cinefex.com / circulation@cinefex.com / website@cinefex.com. Printed
by Valley Printers, Riverside, CA. Copyright © 2006 by Don Shay. All
rights reserved. Reproduction in whole or in part in print or on the
Internet, without written permission is prohibited.

106



Overviews

- 15 **V for Vendetta**
- 25 **The Da Vinci Code**
- 36 **X-Men: The Last Stand**
Jody Duncan
- 70 **Superman Returns**
Joe Fordham
- 106 **Poseidon**
Jody Duncan

Overview

Dan Glass on *V for Vendetta*

Article By Estelle Shay

Visual effects supervisor Dan Glass was just wrapping up on *Batman Begins* when producer Grant Hill and director James McTeigue, with whom he had collaborated on the two *Matrix* sequels, approached him about overseeing the visual effects in *V for Vendetta*. Though certainly smaller in scale than his previous assignments, the project proved irresistible to Glass — particularly since it would reunite him with McTeigue, helming his first feature project after serving as an assistant director on the *Matrix* films, and with producers Andy and Larry Wachowski, whose screenplay, based on an Alan Moore graphic novel, posed some interesting ideas about the nature of terrorism.

Set in a futuristic, fascist Britain, the story revolves around ‘V’ (Hugo Weaving), a mysterious vigilante in a Guy Fawkes mask who singlehandedly takes on the oppressive regime. Ticking names off his personal vendetta list, he sets out to instill terror in those he holds accountable, leaving destruction in his wake while seeking to rouse an apathetic populace to his cause.

With just nine months in which to complete the film, and a mere seven weeks allotted for postproduction once the director’s cut was delivered, McTeigue and Glass determined from the outset that their approach to the effects — in particular the bombings of several London landmarks — would have to take into account their breakneck schedule. “On bigger productions, you generally have at least six months in post. We knew we couldn’t do anything very complex in the CG world, so the decision was made from the start to go with miniatures. It was an overall strategy that applied really to everything — getting as much as we could in-camera, and using compositing skills to tidy it up and bring out the best we had.”

Brought on early in the show to tackle the bulk of the effects work was Cinesite, a company Glass felt was ideally suited to the task. “Cinesite has really been the premiere miniature place in the U.K.; and with their digital division as well, it just seemed like a great opportunity to pair that work with them.” Additional work was assigned to Double Negative, Framestore CFC and Baseblack.



Two challenging explosion sequences bookend the film. The first occurs early in the story, as V invites Evey Hammond (Natalie Portman), a woman he has rescued from a brutal attack, to witness his destruction of Old Bailey, London's criminal court. The other takes place at the conclusion of the film, when V detonates Parliament in a grand gesture designed to launch an all-out insurrection. Glass staged the explosions using scaled-down replicas of the real landmarks, created by Cinesite miniature supervisor José; Granell and his crew and shot on a greenscreen stage at Shepperton Studios.

Modelmakers built two of everything, allowing for two takes of each setup, with four cameras capturing the explosions from various angles. “Normally, we’d have three takes for this kind of event, but because of the budget and schedule, we opted for just two.” A misfire on the first day of shooting dispatched the first of the 1/7th-scale courthouse models with little usable footage. “One of the charges didn’t trigger and the explosion ended up becoming just a ball of smoke that rose up and covered everything. But José was phenomenal. He went in and checked everything to the nth detail for the second take — and it went fabulously.”

Backgrounds for the sequence were tiled together from high-dynamic-range stills shot in bracketed exposures by Glass and Cinesite visual effects supervisor Matt Johnson from a rooftop vantage overlooking the real Old Bailey. “We did a bit of manipulating of the backgrounds and a bit of matte painting work, adding a few skyscrapers and reducing the number of lights. The idea was that there’s a curfew in the city, and we wanted to suggest that people generally conformed to that and went to bed early.”

Capturing the film’s finale — the destruction of Parliament and Big Ben by a train loaded with high explosives that V sends careening down an underground tunnel — required a bit more elaborate planning in terms of design and execution. As the culmination of the film, the explosion had to be orchestrated in such a way as to sell both the believable destruction of a recognizable landmark, and the idea that V stages these events almost as dramatic productions. “We talked quite a bit, early on, about how to make it look like a choreographed explosion. The choice we went with was to have it start centrally on the riverfront, shoot out in two directions along the façade until it reached the edges, then travel up the towers at each end.”

Unlike the Old Bailey, where modelers were able to replace the entire structure with a one-piece miniature, the enormous size of the real House of Parliament made such an approach impractical. Instead, Glass elected to build specific components of the real edifice, then drop them into plates of the actual building. That strategy, however, meant that much more careful attention had to be paid to the miniatures, both in lighting and construction, in order to ensure a perfect match. The components, built in 1/10th scale, included a section of the building façade and two-thirds of the Big Ben tower.

A tracking shot was designed to capture the explosions in a precisely timed manner, following in perfect sync as they rip through the building. “José had this idea that he’d tried once before, where the camera dolly is rigged to actually trigger the explosions as it drives along. It’s a way of ensuring that the timing is correct. So we set that up, and it worked fantastically. We had two cameras on the dolly as it got pulled by a truck, and we were simultaneously shooting wide angles from across the river.” While some closer shots of the destruction required only sky backgrounds, wider views were enhanced with a variety of elements, including



Hugo Weaving dons a Guy Fawkes mask to play the title character in *V for Vendetta*, a cautionary tale based on an Alan Moore graphic novel about a mysterious renegade

additional pyro, smoke and water splashes — shot practically and layered into the composites, along with some CG flaming debris and splashes created by Cinesite.

The explosion reaches its peak with a spectacular display of fireworks that take on the shape of a giant ‘V’ inside a circle. Glass made use of archived fireworks, tracked down by Warner Brothers and scanned by Pacific Title & Art Studio. “I had looked at a lot of CG fireworks, but to me they’re always a little bit clean. With practical fireworks, you get these magical bursts flaring up in the sky, and smoke trails — to have all of that for free was excellent.”

The decision to rely on in-camera solutions whenever possible was behind another seminal moment — a visual metaphor for the unstoppable nature of the coming rebellion — that begins with V tapping a single standing domino to trigger a chain reaction. From above, the camera then pulls way back to reveal a vast array of domino pieces tumbling against one another, flattening to form a giant red ‘V’ against a black background, with just one domino left standing. To accomplish the effect, the production hired Weijers Domino Productions, a company from the Netherlands specializing in custom domino setups, and had them manufacture the dominoes based on designs provided by production designer Owen Patterson. “They came in and did the actual setup. It literally took about three days, working around the clock, to set up 22,000 dominoes, and they had to do it twice because there was a camera angle they didn’t get the first time around. I was quite happy not to have to be on the stage much that day!”

In the end, some minor finessing was required to make the shot work. “We couldn’t physically get a camera with a wide enough lens to actually capture the whole of the top shot. So we photographed the dominoes by themselves all in one plate, then matte-painted up a larger area so that you see V’s character triggering the dominoes from above.” The final shot of the cascading dominoes toppling together from opposite sides, in perfect symmetry, and coming to a rest in support of one still-standing piece was done as a splitscreen.

A practical approach was also used to capture a silhouette shot of V walking naked through a wall of flames — seen during recurring flashbacks to a brutal imprisonment that hints at the origins of

who uses terrorist tactics to undermine a fascist regime and ultimately goad an apathetic public into action. Director James McTeigue and producers Larry and Andy Wachowski called upon fellow Matrix veteran Dan Glass to supervise some 500 visual effects shots, assigned to London-based vendors Cinesite, Framestore CFC and Double Negative. Expressive shadowing of the hard ceramic mask worn by Weaving was the work of Framestore CFC, which also handled all of the film’s digital intermediate work.



In a recurring flashback to his brutal incarceration at the hands of the government, V is seen bursting through a wall of fire in a triumphant escape from his oppressors. Faced with budget and time constraints, McTeigue elected to capture the scene in-camera, calling on stuntman Chad Stahelski – clad only in a G-string and a cooling gel for protection from the flames – to stand in for Weaving. Cinesite enhanced the shot, capturing and compositing additional flame elements to give the illusion of fire encircling the character, while hand-rotoscoped shadowing helped to put him in silhouette.

his vendetta. Determined to get as much real flame as possible in the shot, the filmmakers called upon stunt coordinator Chad Stahelski to test the limits of physical endurance. “We looked at bodysuits, but they’re always readable as bodysuits. So Chad agreed to do the stunt just wearing a G-string. He put a cooling gel all over his skin to protect it, and we did a few takes of him walking forward as the special effects technician raised the level of flames.”

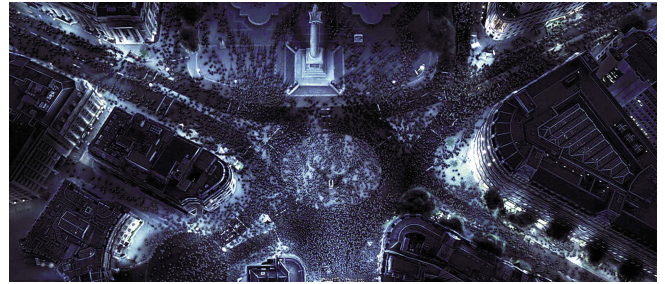
Glass also shot footage of just the flames — cranked up as high as possible — to add to the plate photography as needed. Additional flame elements, photographed against black, were layered in to give the appearance of fire licking back and around the character. “That was all delicate compositing work by Cinesite. The other thing they did was add a shadow in front of Chad to make him appear silhouetted. When we shot it, there was so much light around you could see the whole front of his body. So the shadow was hand-rotoscoped in on the plate, just to get the right sense of fall-off on the edges.”

Despite the filmmakers’ best efforts, not all effects could be achieved in-camera. Such was the case with a series of video inserts for the television monitors and giant video screens depicted in the futuristic London. “We made a lot of valiant attempts to shoot all of that in-camera, and we did manage to get a majority of it onto screens — at least to give the actors something to react to. But there were complications with video formats and with the HD cameras we were using for some of the source footage, as well as issues with editing that inevitably come up when the sync needs to be altered. So that was the first big area where we ended up doing a lot more work than we’d originally planned.” Ultimately, the monitor work was assigned to visual effects supervisor Richard Briscoe at Double Negative in London. “They set up such an efficient pipeline for dealing with those shots that it was very easy for me to say to James: ‘Okay, you want to adjust that? Fine. We can deal with that.’”

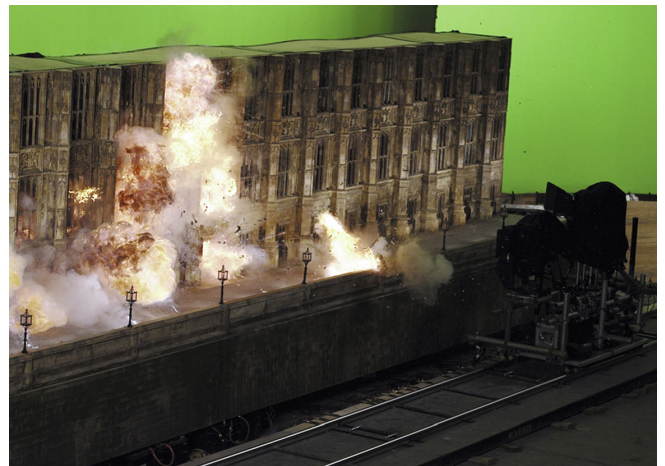
Another scene requiring digital intervention was one in which thousands of incensed demonstrators dressed identically in Guy Fawkes masks and capes move through the streets of London toward the House of Parliament to face off against armed troops. Glass knew, from the outset, that those shots would require digital manipulation to enlarge on the crowd of several hundred extras. “The three nights that we were shooting on location in Trafalgar Square were incredibly restrictive. We weren’t allowed to begin putting our set dressing out onto the streets until midnight; and because we were shooting in the summer and the sky would begin to brighten by about 3:30 a.m., our shoot window was only about four and a half hours. Also, though we were incredibly lucky to be able to shoot right there at the House of Parliament, we were only allowed to close the streets at ten minute intervals. So we’d have to get four or five hundred extras into place, do a take, then basically clear everybody out and let the traffic through. As a result, for the crowd replication work, we couldn’t resort to traditional methods of tiling, where you shoot a bunch of people in one spot, then move them around to different areas of the frame and shoot them again. And we certainly couldn’t roll out any greenscreens for the people in the foreground. It was very much a matter of just shoot and see what you get. “ In postproduction, Cinesite employed 2D cutting and pasting to build a seamless composite that would turn the hundreds of extras into thousands by laboriously hand-rotoscoping people from other takes and other plates of the crowd scene, and dropping them in as needed.

Three aerial shots depicting the huge throngs of masked demonstrators moving across a bridge and pouring into Trafalgar and Parliament Squares were done as complete 3D simulations, using Cinesite's proprietary crowd simulation software. "In addition to the restrictions we faced on the ground, there was no way anyone would let us go up in a helicopter at the same time and shoot from above, because of restrictions on airspace above Parliament. Also, the London bombings had happened around that time, so that made things especially itchy. We did manage to get a bunch of photographers onto rooftops on the night of the shoot; so at least we had some reference for what it would look like from above."

The 3D simulations made use of detailed digital doubles of V that Cinesite artists had created earlier, in anticipation of some CG stunt double work that never materialized. Animators also applied varied walk and run cycles obtained by the company during a motion capture session at Artem Digital. "Fortunately, we knew from the outset that the crowd stuff wasn't going to require any complex interaction between figures; and, of course, it helped greatly that all the figures were wearing the same costume and the same mask. On the other hand, I was very keen to make sure that every hat was worn a little differently, every gait was slightly different, every body build and size, and so on. So we paid quite a lot of attention to that."



A high-angle view above London reveals thousands of angry demonstrators dressed identically in Guy Fawkes masks converging on Parliament from every direction. Cinesite employed its proprietary crowd simulation software to accomplish the all-CG shot, using a digital double of V altered slightly to produce a variety of body builds and animated with walk and run cycles obtained through motion capture. Digital artists used 2D crowd replication techniques for ground views of the rebellion, cutting and pasting to build a composite from multiple takes of 500 costumed extras filmed at the real locale.



For the fiery destruction of the House of Parliament at the film's climax, Cinesite's model department built sections of the enormous edifice in miniature, then rigged it with pyrotechnics and captured the explosions on a greenscreen stage with a high-speed camera. To ensure precise timing of blasts for an elaborate shot traversing the length of the building's facade, the camera was mounted on a dolly rigged to cue the explosions as it moved along the track.

Digital effects also played a part in a series of shots of V demonstrating his prowess with knives. In a fight sequence at a London underground station, the masked vigilante appears to move at hyperspeed, flinging his blades with deadly accuracy before his opponents can even draw their weap-ons. Though Glass had anticipated the need for CG knives to slow down the knife trajectories and show them spinning through the air, the shot count grew when the Wachowski Brothers — in charge of second unit work on the sequence — envisioned a more elaborate effect. “As Larry and Andy were designing the fight, they came up with this idea of trails flowing off the knives — something between a motion blur and an anim  trail — to emphasize the fact that V moves much faster than anyone around him.”

While most of the film’s effects were grounded in a look of reality, the knife shots represented a departure from that approach, taking on a more stylized, albeit still subtle look. To lock down the design of the shots in advance, Glass commissioned George Hull, who had done conceptual artwork for *The Matrix*, to knock out some quick sketches of how the trails might look. “James, Larry and Andy picked the look they liked and we sent that off to Cinesite, where they developed it in a 3D pipeline, modifying it slightly, just in terms of the final levels of transparency. They played a bit with the smokiness of it, adding a bit of cigarette-smoke waft or wispi-ness. That really helped in shots where things had to pass through the trails.”

Aside from the more obvious effects, *V for Vendetta* also made use of color grading and other subtle techniques to suggest certain mood shifts, or to address problems related to lighting. For those tasks, Glass and the production’s digital supervisor Tom Debenham worked closely with Framestore CFC, in charge of digital intermediate work on the film. “I think this is a crossover area that we will be seeing more of in the business of making films, partly because the sophistication of DI has evolved to the point where there are a lot of things you can now do that might traditionally have been reserved for visual effects. It’s a very subtle division, and there are still points where you transgress back into visual effects. For example, Tom and I would sit in the DI suite with Framestore colorist Adam Glasman and do whatever adjustments of lighting or mood shift that James was after. But there would be a point at which it would break, where it took too much time to deal with in the DI suite. And that’s the point at which we’d say: ‘Okay, let’s take that off to Visual Effects Land and touch it up there.’”



A closeup view of Big Ben destructing made use of a highly-detailed replica of the real clock tower.

Such was the case with the Guy Fawkes mask worn by Hugo Weaving throughout the entire movie. The hard ceramic mask posed lighting challenges for the filmmakers, given its stark white coloration juxtaposed against the character's all-black attire. "It was a nightmare for our director of photography, Adrian Biddle. Close up, he could control shadows on the mask to give it more expressiveness. But as soon as you pulled further back, if you wanted to see any information in the dark clothing, you had to throw a lot of light at it — and that suddenly made the mask beam like a skull." Glass turned to Framestore for a solution. There, senior compositing artists Jonathan Fawkner and Adrian De Wet and a small team went to work creating a 3D version of the real mask that could be used for shadowing purposes. "Framestore was the natural choice for doing the mask shadow work because some of it could be handled just within the DI suite — specifically shots where V wasn't moving very much. But for shots where he was moving around a lot — doing head turns and tilts and nods — they would take that into the CG world where they built a very efficient way of tracking their CG mask to the filmed mask and placing a few lights. Rather than making it a full composite, we just generated shadow maps and passes that went back to the DI suite, where they could match it into everything else. So it was really very much an assist to the DI process."

Though its effects slate grew over the course of nine months from an initial 120 shots to some 500, *V for Vendetta* could hardly be considered an effects-driven show by modern standards.

Nevertheless, for Dan Glass it was an exercise in resourcefulness. "When you're working at the opposite end of the spectrum in terms of budget and timeline and resources, it really tunes your mind in a different way, which I thoroughly enjoyed. I suppose if we'd had more money and time, we might have used motion control or built more miniatures. But that said, I'm not at all unhappy with the way things turned out. It was appropriate for this film that it wasn't about big-budget visual effects. So it always felt right that we took the approach we did."

V for Vendetta photographs copyright © 2006 by Warner Brothers. Miniatures unit photography by Redpill Productions.



Wide views of the destruction of Parliament were achieved by dropping the exploding model facade directly into live-action plates of the real locale, filmed from across the river. Though closeup shots required only sky backgrounds, the wide views were heavily augmented with pyrotechnics, smoke and water splashes, captured separately as practical elements and layered into the mix. Other elements included flaming debris, sparks and water splashes generated digitally by Cinesite.

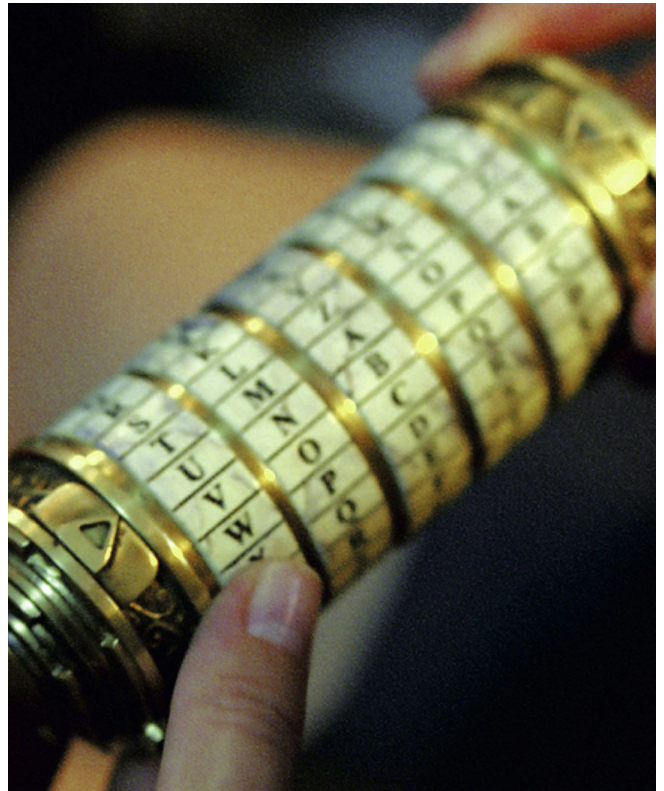
Overview

Angus Bickerton on *The Da Vinci Code*

Article By Joe Fordham

Religious heresy, historical speculation, or old-fashioned mystery thriller — any way you slice it, Dan Brown's novel, *The Da Vinci Code*, stirred interest and controversy, resulted in sales of more than 40 million copies worldwide and was prime material for a cracking summer feature film.

Produced by Imagine Entertainment and Columbia Pictures, the fast-moving tale revolves around the exploits of Robert Langdon (Tom Hanks), a Harvard symbologist called in to investigate a series of cryptic clues left by an art historian found murdered in the Grand Gallery of the Louvre in Paris. Mysteries deepen as Langdon and Sophie Neveu (Audrey Tatou), a cryptologist with the French Judicial Police, become inveigled in a race to decipher hidden meanings in the art of Leonardo Da Vinci, revealing a 2,000-year-old ecclesiastical cover-up, an alternate take on Christ's life and a possible location of the Holy Grail.



To bring the story to cinematic life, screenwriter Akiva Goldsman and director Ron Howard investigated methods to visualize complex exposition. “Ron and Akiva wanted to illustrate the history mentioned in the novel,” stated visual effects supervisor Angus Bickerton. “They wanted to show Jerusalem at the time of the Crusades, and Rome circa 300 A.D., at the time of Emperor Constantine. There was also a practical angle. The controversial nature of the material meant access to key locations wasn’t going to happen. So we had to either find alternative locations, or we had to re-create them.”

Vatican opposition to Brown's book placed restrictions on shooting in ecumenical sites, not only those of Roman Catholic origins. “It first seemed that we would gain access to Westminster Abbey, which is a Protestant church, but suddenly they closed their doors, as well. It was as if, after 500 years of Reformation, they decided to patch things up with the Roman Catholic Church! We weren’t allowed to shoot inside the abbey because it had strong links to the royal family, and they didn’t want to upset the Roman Catholic Church; but we were allowed to shoot inside Lincoln Cathedral, which was a 15-percent smaller, but fairly good facsimile of Westminster. The Dean of Lincoln welcomed any discussion about the Bible and about Jesus. And, without being cynical, he also valued the income toward the restoration of the cathedral.”

Rose Line Productions — named after one of the novel's key religious symbols — set up a base of operations at Shepperton Studios in England and commissioned The Moving Picture Company, led by visual effects supervisor Gary Brozenich, and a team at Double Negative, led by Paul Riddle, to provide the lion's share of visual effects, with additional work contributed by Rainmaker U.K., *The Senate* VFX and the production's one stateside vendor, Brainstorm Digital. *Altered States* FX created prosthetics, Dominic Tuohy supervised physical effects on locations in the United Kingdom and Malta, and Philippe Hubin supervised physical effects in Paris.

The French Ministry of Culture permitted filming of key scenes in and around the Louvre, including opening scenes of the murder of museum curator Jacques Saunière (Jean-Pierre Marielle). *Altered States* makeup effects supervisor David White fashioned a likeness dummy of the actor, nude and spread-eagled in the position of Da Vinci's Vitruvian Man. "It was a stunningly, horribly, realistic corpse, cast out of very waxy silicone from a lifecast of the actor. We shot for one night in the Grand Gallery at the Louvre. Production designer Allan Cameron then built a replica Louvre on the 007 Stage at Pinewood. But even that stage, which is huge, could accommodate only about a third of the Grand Gallery, which is nearly a quarter of a mile long. On our one night in the Louvre we shot bracketed digital stills and motion picture plates down the center of the gallery and close to the walls, then we put a bluescreen at the end of the 007 Stage and MPC tracked in extensions."

Since Da Vinci's priceless oil paintings, housed in an annex adjoining the Grand Gallery, were off limits to the filmmakers, production commissioned custom reproductions. "Allan Cameron hired a great scenic artist, James Gammill, who also specialized in replica paintings. The art department used photographs of paintings we needed in the film, blew them up to original dimensions and printed them on canvas. Depending on how closely they were seen, Jamie then applied lacquers and varnishes to age them and, in special cases, like the Mona Lisa and Madonna on the Rocks, retouched them by hand so we could get up close to see textures and light shining off the surface."

Saunière's assassin, an albino monk, Silas (Paul Bettany), is seen practicing a grisly 'corporal mortification' self-mutilation ritual. Makeup designer Veronica Brebner created Bettany's albino makeup, while MPC enhanced effects of Silas flagellating his own body, tracking additional scarring and blood effects to Bettany's back.

Silas tracks down a sacred keystone, a crucial part of the Da Vinci mystery, hidden in a 17th-century Paris church at Saint-Sulpice. The church was off-limits to filming, so Angus Bickerton visited Saint-Sulpice and surveyed the location as a tourist equipped with digital video camera. "I shot a test, walking down the aisle, and then I photographed digital stills from the beginning, middle and end positions. I gave that footage to Rainmaker and asked them if they could project the stills onto basic geometry of the church and mimic my DV shot. They did a brilliant job, and that won them the assignment." Allan Cameron's team re-created the Saint-Sulpice altar and a 30-foot-tall portion of the north transept of Saint-Sulpice church on C Stage at Shepperton, and then surrounded the set with greenscreen on three sides. After Ron Howard shot Bettany in the greenscreen set, Rainmaker's team, led by Mark Breakspear, generated extensions, projecting digital textures onto 3D geometry to simulate the gothic church interior.

Departing the Louvre as fugitives implicated in Saunière's death, Langdon and Neveu head for the U.S. Embassy in Sophie's ultra-compact Smart Car. Production shot the Smart Car sequence practically, with Hanks crammed beside Tatou in the tiny vehicle. Paris stunt coordinator Rémy Julienne rigged Smart Car interiors with cameras on platforms mounted around the car, and oversaw action choreography. For a scene in which French police block access to the U.S. Embassy, causing Neveu to reverse at high speed up a one-way street, Team Julienne rigged a special car by reversing a Smart Car chassis. The stunt driver sat facing the back window and wore a backward costume and likeness mask of Langdon, Hanks' face on the reverse, created by the makeup department and *Altered States FX*. "The driver had black-shrouded arms and gloves on a steering wheel that came back through the seat. It worked brilliantly, but it was very bizarre to see him hanging around between takes, smoking a cigarette with his backward arms and head."

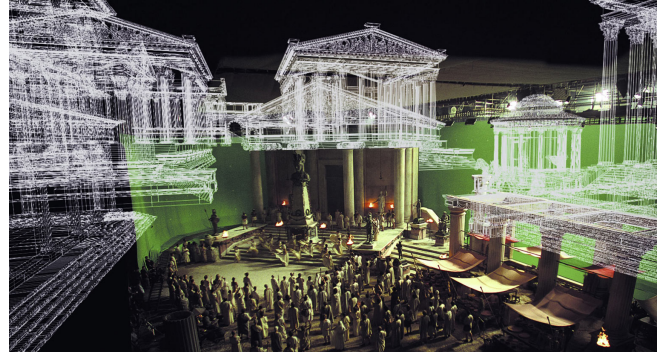
Langdon's escape intercuts with scenes of papal intrigue at Castle Gandolfo, a Vatican astronomical observatory, filmed at several English stately homes. Beaulieu House, a 14th-century mansion in Hampshire, served as Gandolfo's exterior for establishing shots, modified by Double Negative matte painter Neil Miller, who added architectural details including two incongruous rooftop astronomical domes. For a nighttime aerial shot, the production shot daytime helicopter plates over Belvoir Castle, a 19th-century residence in rural Leicestershire. Double Negative then boujou-tracked the plates, and added 3D geometry to rebuild the top half of the building.

As Langdon discusses an ancient Christian military order, the Knights Templar, the scene shifts to 12th-century Jerusalem in a flashback generated at MPC. "MPC was a prime choice for flashbacks to Jerusalem, after their superb work on *Kingdom of Heaven*. We didn't have anywhere near as extensive scenes, but we did have one wide shot of the siege on Jerusalem. However, whereas Ridley Scott shot his *Holy Land* with a massive two-sided set in Morocco, we shot on a wet, blustery day in a quarry in Leighton Buzzard in North London with no set at all."

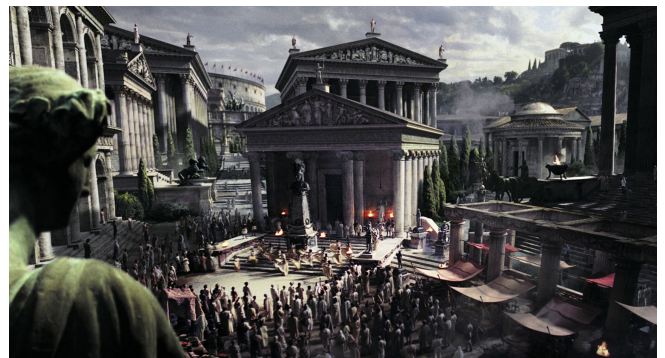


To bring Dan Brown's mystery thriller *The Da Vinci Code* to the screen, director Ron Howard employed a seamless blend of location photography, studio work and visual effects to penetrate the inner sanctums of several ecclesiastical settings that were off-limits to the production. For an early scene in the film, visual effects supervisor Angus Bickerton commissioned Rainmaker U.K. to generate a digital re-creation of Saint-Sulpice, a 17th-century church in Paris, utilizing digital still imagery of the actual church interior and 3D architectural

extensions to expand production designer Allan Cameron's partial set built at Shepperton Studios in England. The partial set encompassed a replica of the Saint-Sulpice altar, with ornate stonework, statuary and a 30-foot-tall portion of the north transept of the church, scaled down to fit the available studio space and surrounded on three sides by greenscreen. Ron Howard filmed performers in the set, referencing a computer model of the CG church interior generated at Rainmaker. Digital artists then derived digital texture maps from photographic surveys of the sanctuary, projected the texture maps onto 3D geometry, and rendered the giant vaulted chamber with atmospheric volumetric lighting effects.



To illustrate the complex historical back-story underlying the novel's serpentine plot, the film presented several flashbacks to ancient times, including a re-creation of ancient Rome, circa 300 A.D., depicting the Emperor Constantine addressing a gathering of religious leaders. Allan Cameron designed a partial set surrounded by greenscreens to capture live-action portions of the scene with costumed extras at Shepperton. / The Senate VFX then generated digital set extensions employing 3D models and matte paintings, rebuilding and improving the detail in existing virtual backlot models of ancient Rome.



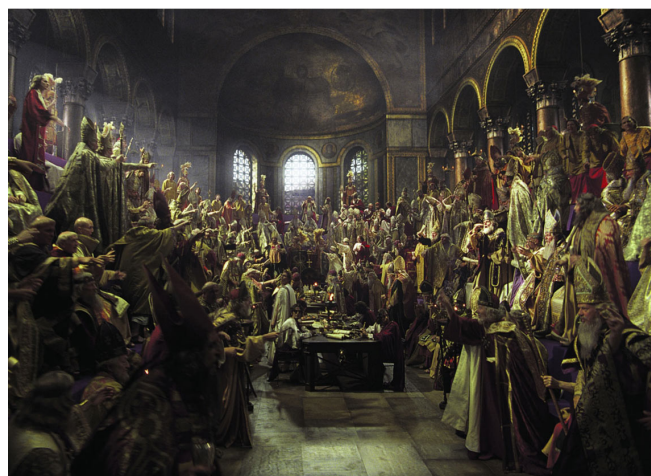
Emperor Constantine summons the first ecumenical conference of bishops of the Christian Church at Nicea, in Turkey, a historical event that plays a prominent role in conspiracy theories implying imperial control over the church. Allan Cameron constructed a partial set of the council chamber at Shepperton, backed by a 270-degree bluescreen. / The Senate previsualized a motion control camera move on the partial set, allowing visual effects to multiply 200 costumed extras using three repeat passes.

Digital artists then matchmoved characters into a 3D council chamber and extended the set around the performers, projecting painted textures onto 3D chamber geometry.

The quarry owners flattened out the rocky terrain for the shoot, then production craned in a motion control rig. Dominic Tuohy's physical effects team and stunt coordinator Greg Powell staged a cavalry charge with 200 extras in period costumes. "We had approximately 50 Crusader knights on horseback, and 150 infantry bearing flags and carrying ladders. MPC created all the siege artillery and trebuchets as CG. Gary Brozenich did a survey of the quarry with Plowman Craven Associates, and we shot a motion control survey pass with lots of markers all around the quarry. It was too windy for greenscreens, so we opted for pure roto, together with MPC's crowd simulation software. We prevized camera positions, then recorded the camera move of horse riders riding past. We then did repeat passes of the foreground crowd. MPC added tens of thousands of people beyond that as CG."

MPC also contributed to a scene revealing the inner workings of a mechanical security device, a 'cryptex,' that Langdon and Neveu recover from the vault of a Paris bank. Allan Cameron's art department designed the cryptex to resemble an ornate, oversized bicycle combination lock, approximately five inches long. Art director Giles Masters created conceptual designs of the interior, illustrating a cylinder of five geared rings and delicate internal mechanisms. MPC extrapolated on the designs to create a mind's-eye journey into the cryptex. "We tried to make it look like it had been made in the 17th century, referencing ornate period armaments. Gary Brozenich's team mimicked the look of an endoscopic probe that carried its own internal light, with lens distortions, chromatic aberrations, barrel lens effects and color diffraction at the edges of the frame."

Seeking a solution to the cryptex code, Langdon and Neveu visit an eccentric Grail scholar, Sir Leigh Teabing (Ian McKellen), who reveals possible clues in Da Vinci's painting of Christ and his apostles, *The Last Supper*. The filmmakers illustrated Teabing's history lesson using high-tech digital hardware, furnished by Useful Companies. "Ron Howard worked closely with Useful Companies on a scene showing the Grail symbol 'V' between Christ and an adjacent figure in the painting who is supposedly Mary Magdalene. Useful Companies generated graphics in After Effects, and ran the animation on a large Sony flat-screen monitor fed from off-screen using real-time drives. Sir Ian



operated a Wacom graphic tablet, which triggered a couple of the animations as he wrote on the screen. The power of his performance made it a really gripping scene.”



Harvard symbologist Robert Langdon (Tom Hanks) and French cryptologist Sophie Neveu (Audrey Tatou) doggedly pursue clues to a vast conspiracy that leads them to Westminster Abbey, site of the 1727 funeral of Sir Isaac Newton. Ron Howard photographed Hanks and Tatou on location in London, approaching Westminster Abbey. The Moving Picture Company then created a ghostly flashback to Newton's time, placing Langdon and Neveu among specters of the 18th-century mourners by fading in bluescreen elements of costumed performers and adding a digital re-creation of wooden scaffolding around the abbey's south tower, which was under construction at the time of Newton's death.



Neveu recalls a long-suppressed memory of a horrific car crash that resulted in her birth parents' death. For an interior angle of the crash, the physical effects team rigged a Citroen DS to a rail on a bluescreen stage. Performers rode the rig, which simulated forward movement. Double Negative then added windshield views of a truck on collision course.

Teabing's monologue leads into a flashback, panning from McKellen to a scene in ancient Rome. The Senate VFX rotoscoped the scene and generated a transition to an actor portraying the Emperor Constantine, filmed at Shepperton on a partial set surrounded by a 270-degree bluescreen. The Senate visual effects supervisor James Madigan and digital set designer Vlad Bina drew on *The Senate's* experience on the HBO mini-series *Rome* in rebuilding and improving detail of existing Roman backlot CG models to extend the set. For a flashback to Constantine's gathering of bishops at the Council of Nicea, in ancient Turkey, artists previsualized a motion control camera move on a partial set, then multiplied 200 extras in three repeat passes and matchmoved characters into a 3D council chamber.



Physical effects and the stunt team staged crash exteriors, and captured the interior camera angle, by running a truck into a crushable rail-mounted car, filmed on an automotive test track in England. Double Negative then composited Neveu's parents into the wreck.

The historian's insights lead Langdon and Neveu to England, conveyed aboard Teabing's private jet in a night flight over the English Channel. Double Negative modeled and rendered jet exteriors digitally for all airborne shots and for a scene of the plane's arrival, filmed on location at Biggin Hill Airport in Kent. "They shot a really nice long-lens daytime shot of the plane taxiing along the runway, and they asked us to grade the shot down to day-for-night. I suggested we could also do it all CG to create the correct reflections and lighting on the aircraft. Double Negative used the daytime shot as a guide, animated an aircraft on top, and photographed out-of-focus lights in the background to create big circles of confusion. I think most people will have no inkling it's CG."

Langdon and Neveu make their way to Westminster Abbey, pursuing a clue possibly hidden in the tomb of physicist Sir Isaac Newton. MPC created a flashback for the scene in which Hanks and Tatou, viewed from a high angle, approach the abbey. As the camera tilted up toward the massive structure, MPC generated a transition to the environment as it appeared at the time of Newton's death, in 1727. "The two main towers of Westminster Abbey were still under construction at the time of Newton's funeral, so we clad one of the main towers in wooden scaffolding. Then we faded in ghosts of the funeral procession leading into the abbey, which appear around Langdon and Sophie."

MPC boujou-tracked shots of Hanks and Tatou, and converted the data into motion control moves for a bluescreen ghost shoot at Shepperton and an additional day of shooting from a high crane in a field in Lincoln. "We purchased 250 square meters of approximately-bluescreen-colored carpet, laid it out in a field on a wonderful sunny day, and shot about 20 takes of 200 local extras from cranes looking down, which we multiplied to create the exterior procession." MPC blended ghosts at 80-percent opacity into digital matte paintings of historic London, and then animated a camera move passing through Westminster Abbey's bell tower. "Gary Brozenich and his team photographed a lot of present day bell towers, and went into a bell foundry to take photographs there. Then they created a fantastic CG bell tower, entirely fictional to the workings of Westminster Abbey, but

entirely photorealistic.” The camera passes peeling bells and connects with footage filmed in the interior of Lincoln Cathedral. “Ian Menzies of Motion Control Cameras mounted a custom rig with a Mark Roberts camera head in the highest balcony we could get to in Lincoln Cathedral. We finished off the move and shot multiple passes to see the mourners of 1727 gathering in the abbey.”

With Newton’s tomb off limits for any photographic purposes, Allan Cameron’s team built a facsimile of the monument, reconstructed inside Lincoln Cathedral. The tomb was featured in a scene in which Langdon feverishly attempts to recall the details of the sculpture, his mind’s-eye point-of-view searching for visual clues to decipher the cryptex code. Double Negative created the effect by digitally reconstructing elements of the practical set piece. “Double Negative prevized camera moves around Langdon as his mind’s eye searched for the clue somewhere in the tomb. We matched those as best we could with Tom Hanks in the Chapter House at Lincoln, then tracked the plates and turned them into mo/co moves for Ian Menzies’ Wotan rig moving around the tomb on K Stage at Shepperton. We composited that around Tom, revealing the tomb in a play of light from the window, very ghostly and distorted, with chromatic aberrations and spectral effects of offset colors.”

The cryptex clue leads Langdon and Neveu to Rosslyn Chapel, a Scottish site long associated with the Grail myth. Howard filmed interiors on location inside Rosslyn Chapel and in a fictional subterranean chamber built by Allan Cameron’s team at Shepperton. Restoration work at Rosslyn, which surrounded the medieval structure with scaffolding and a large tin roof, prevented clear establishing shots. “Leigh Took at Mattes & Miniatures at Pinewood built a 1/5-scale miniature of Rosslyn for our exteriors. We only built the parts we needed to see: two sides and a roof. We mounted it on a three-foot rostrum in a field at Bray Studios, overlooking Oakley Court, a nearby stately home. We took photographs of trees, printed them up six-foot high and stuck them on either side. Then, in classic Derek Meddings style, we lined up our shot to see the horizon, the real sky and a bit of Oakley Court, waited for the light, and shot it at 36 frames per second.” Double Negative used miniature textures projected onto 3D geometry tiled into a digital matte painting for an aerial establishing shot.

Revelations at the chapel trigger a flashback to Neveu’s personal history as the young woman recalls a long-suppressed memory of a horrific car crash that resulted in her birth parents’ deaths. Ron Howard initiated the flashback from the child’s point of view, as Neveu’s parents turn to regard their daughter in their car’s back seat. Performers enacted the scene on a bluescreen stage in a mockup of the car mounted on a rail, which simulated forward movement enhanced by air mortars at the moment of impact. To film exteriors of the head-on impact between a Citroen DS saloon car and a truck, Dominic Tuohy’s team collaborated with the stunt department to rig a crushable Citroen at an automotive test track. “The truck and car were on a big pulley system with the stripped-down Citroen riding on a rail. As the truck drove toward the car, it pulled the car toward it and they impacted at a combined speed of 70 miles per hour. We put a camera inside the Citroen, and Double Negative bluescreen-composited Sophie’s parents into the car, so they appeared to be inside as it caved in around them.”

Langdon returns to Paris where a flash of inspiration leads him to what may be the object of his quest, hidden in plain view beneath the glass Inverse Pyramid above the entry to the Louvre. Hanks performed the scene on location, walking out on top of the modern art structure in Versailles, as a

Louma crane rose above him and then descended. Double Negative rotoscoped Hanks from the scene, rebuilt the pyramid digitally, matchmoved the shot and penetrated the surface of the glass, descending through the pyramid's inner scaffolding to a smaller pyramid beneath. "We suggested this was just the tip of a much larger subterranean pyramid. In a couple of frames, we broke through the surface of that and continued in a mo/co move shot at Shepperton to reveal a sarcophagus. Earlier in the film, we showed the Knights Templar protecting this sarcophagus, which was inscribed with a likeness of the actress who played Mary Magdalene. For our last shot in the film, we changed the face on the sarcophagus to a cyberscan of Audrey Tatou, and as we ended up on a closeup — if you look closely — we revealed Mary Magdalene's profile looking very much like Sophie's."

The subterranean revelation concludes 480 visual effects shots, out of approximately 650 developed for the film. "Ron Howard's team were close confederates who had worked together many times before. They worked very fast, with multiple cameras, and shot a million and a half feet of film — more than were shot for *Apocalypse Now!* That allowed them to whittle away at the story, and several scenes fell by the wayside — or fell into the extended video release, which kept us busy with another 80 shots for four weeks after the theatrical release. Our job, as visual effects artists, was to give Team Howard the flexibility to help refine the narrative. It was a fabulous pleasure to be part of that team."

The Da Vinci Code photographs copyright © 2006 by Columbia Pictures.



Langdon and Neveu near the end of their quest at Rosslyn Chapel in Scotland. Ron Howard photographed interiors on location inside Rosslyn and in a fictional subterranean chamber built at Shepperton. Ongoing restoration work at the medieval structure prevented unobstructed exterior shots, so the visual effects team employed a 1/5-scale miniature of the building, built at Mattes & Miniatures and filmed at Bray Studios, in England. Miniatures director of photography Rick Mietkowski, Angus Bickerton and gaffer Sean White attend to the completed miniature, positioned atop a platform that allowed alignment with the natural horizon and landscape.

Dark Phoenix Rising

image

ARTICLE BY JODY DUNCAN

Issues of medical ethics — specifically, the thorny question as to when, or if, an abnormality should be characterized as an undesirable affliction — are weighty themes for an action movie based on a comic book; but they form the central conflict of *X-Men: The Last Stand*. In the film, directed by Brett Ratner, outraged members of the mutant citizenry, incited by Magneto (Ian McKellen), seek to destroy a mutant cure that would strip them of their powers and reinstate them as ‘normal’ members of society. Always the moderate opponent to Magneto’s radical philosophies, Dr. Charles Xavier (Patrick Stewart) and his *X-Men* join the government in protecting the cure — and, with it, the rights of those who wish to avail themselves of its promise for a more mainstream existence. Against the backdrop of this ethical battle is the mysterious reappearance of Dr. Jean Grey (Famke Janssen), a former member of the ‘X’ team who was thought to have been drowned in a rush of water from a broken dam at the end of *X2: X-Men United*. In *The Last Stand*, the franchise’s third — and ostensibly final — installment, Grey is reborn as an omnipotent ‘level five’ mutant, controlled by a dark force known as the Phoenix.

The supernatural powers of the Phoenix and other mutants in the film are displayed in a series of spectacular visual effects sequences, created under the imaginative helmsmanship of visual effects supervisor John Bruno. Working with co-producer Kurt Williams and additional visual effects supervisor John Desjardin, Bruno orchestrated the collaboration of ten visual effects houses in the United States, England, New Zealand and Canada. Together, The Moving Picture Company, Framestore CFC, Weta Digital, Cinesite, Hydraulx, CIS Hollywood, New Deal Studios, Lola Visual Effects, Soho VFX and Kleiser-Walczak contributed approximately 900 effects shots to the show. In addition, makeup and creature effects studio *Spectral Motion* realized a number of key live-action mutant characters.

Notwithstanding the long list of postproduction vendors, John Bruno, from the earliest stages of preproduction, committed to a predominantly in-camera approach to the effects, a decision encouraged and supported by special effects coordinator Mike Vezina and stunt coordinator and second unit director Simon Crane. “We had 12 months to make this movie, from start to finish,” Bruno commented, “and the only way to make that incredibly short schedule was to shoot as much as we could in camera. I prefer the look of in-camera effects anyway. In fact, initially, I even tried to get the studio to agree to build a full-size X-Jet that we could shoot live, like we did with the Harrier jet in *True Lies*. They said ‘no’ to that; but they did agree that we should shoot as many practical elements as possible, and only use CG when we had to. My goal was to attempt to do 80 percent of our shots practically, with just a little CG enhancement. And I was able to reach that goal in a lot of shots featuring the main actors. Simon Crane came up with all these fantastic wirework rigs, which enabled the actors to do some big, complex stunts — which meant we could often get by with just a

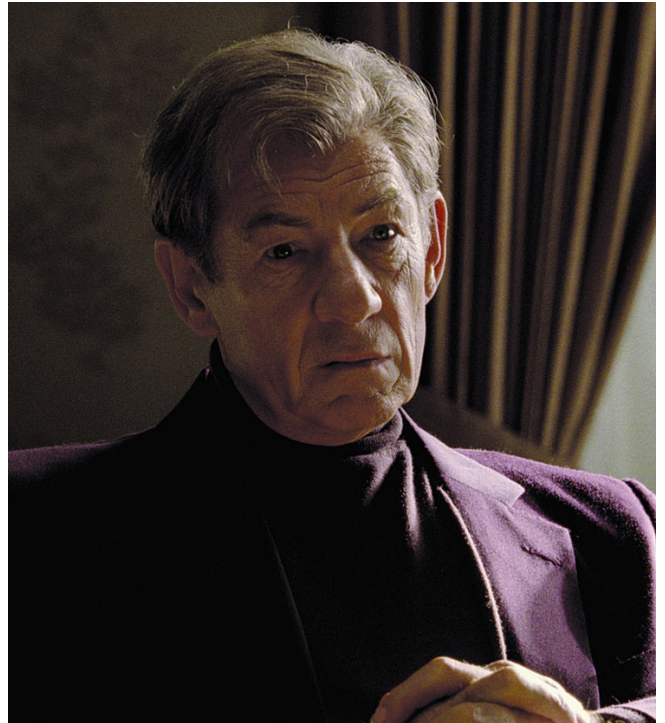
bit of wire removal instead of having to go to a CG character every time. My feeling was that we would add CG doubles only as a last resort, if there was absolutely no way to get it in-camera.”

X-Men: The Last Stand opens with a flash-back to 1985, as Xavier and Magneto visit the girl Jean Grey at her family home. Rather than cast more youthful actors to play the 20-years-younger characters, or rely on prosthetic makeups, Ratner shot Stewart and McKellen as is, then turned to an innovative digital technique to de-age them after the fact. Greg and Colin Strause of Hydraulx oversaw about two dozen de-aging shots, executed by their sister company, Lola Visual Effects.

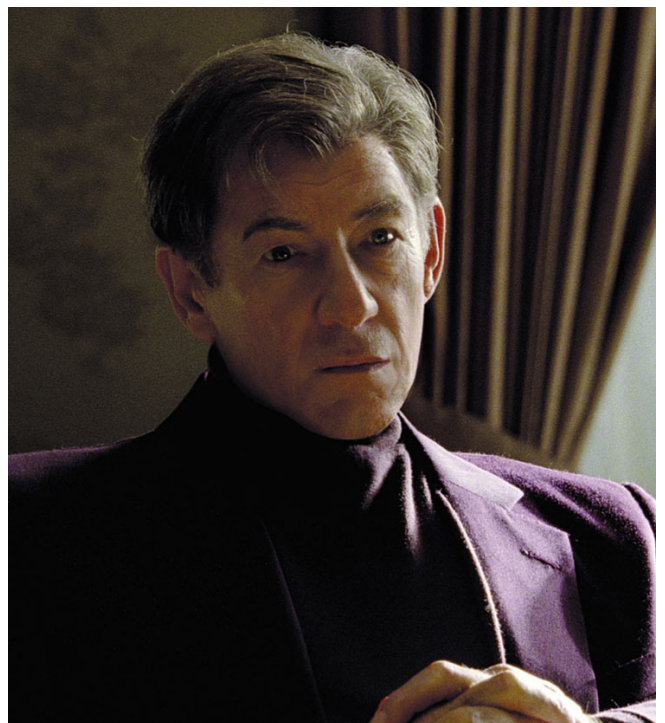
To start, the effects team conducted extensive studies of McKellen and Stewart as they appeared 20 years ago. “We grabbed every photo or scene from a movie we could find from their earlier years,” Greg Strause said. “We even consulted with a plastic surgeon to tell us exactly how they had aged. In order to figure out how to make them look younger, we had to know what it was that made them look older.”

Led by Edson Williams, Lola artists then de-aged Stewart and McKellen through a proprietary frame-by-frame digital process dubbed ‘digital skin-grafting,’ producing a result that was far beyond the digital equivalent of smearing Vaseline on a camera lens. “Normally,” Colin Strause noted, “when you want to erase wrinkles on someone for a commercial or music video, you blur them out and add grain to hide them. But this was a lot more involved than just blurring out wrinkles. When you look at this, there is no blur. All the pores and skin texture details are still there. That was important because we have extreme closeups on these characters. In some shots, they are full-frame, chin to forehead.”

Digital skin-grafting reversed the ravages of age by manipulating lighting, bone structure and tissue mass — all on the Inferno. “We didn’t use any CGI, no 3D elements,” remarked Greg Strause. “Instead, we grabbed skin from other parts of the photography or from other samples that we’d shot; and then — specific to the lighting in the shot — we tracked those skin patches onto the actor’s face.” Sometimes the effect involved diminishing a feature that had grown larger with age — again, without resorting to 3D. Rather than build and track in smaller CG ears on Ian McKellen, for example, Lola shrunk the actor’s actual ears in the live-action plates. “The moment you start tracking in something like CG ears, you change the character of the original actor, and it doesn’t look quite right. To avoid that, we just shrunk Ian’s existing ear. Not only was that more cost effective, it gave us a character that was really Ian McKellen. It was Ian McKellen as a young man, not a CG Ian McKellen or an Ian McKellen double. There is something great about retaining all of the intangible qualities of your original actor.”



Stewart and McKellen played their 20-years-younger selves without makeup appliances, and were de-aged in postproduction by Lola Effects, which employed a proprietary process dubbed 'digital skin-grafting.' Executed entirely on the Inferno and relying on no 3D computer generated elements, the digital skin-grafting technique involved artfully and judiciously tracking skin and bone structure samples – captured from the live-action photography or other photographic reference – to the actor's face and head, specific to shot lighting.



Stewart and McKellen played their 20-years-younger selves without makeup appliances, and were de-aged in postproduction by Lola Effects, which employed a proprietary process dubbed 'digital skin-grafting.' Executed entirely on the Inferno and relying on no 3D computer generated elements, the digital skin-grafting technique involved artfully and judiciously tracking skin and bone structure samples – captured from the live-action photography or other photographic reference – to the actor's face and head, specific to shot lighting.

"This technique could revolutionize filmmaking," concluded Colin Strause, "because it will open up the ability to do these kinds of flashback scenes. There are some really cool projects that have been out there a long time — projects where you see characters at different ages — with no way to do them. The studios have said, 'Wow, that's a great book or a great concept — but how the hell do we do it?' Now there is a way, without spending millions of dollars on an all-CG character."

After the flashback scene, the narrative shifts to the present day, with X-Men instructors Storm (Halle Berry), Wolverine (Hugh Jackman) and Colossus (Daniel Cudmore) and students from Professor Xavier's School for Gifted Youngsters seemingly engaged in combat with an unidentified enemy. The battle is revealed to be merely a training exercise when the holographic terrain dissolves to the school's Danger Room.

Though Hydraulx created a digital version of the armored Colossus for stunt gags and transformations from his human form as Peter Rasputin, production maintained its in-camera philosophy by shooting, as much as possible, Cudmore in a metallic head-and-suit created by Spectral Motion. The film's producers provided Spectral Motion founder Mike Elizalde and his crew with voluminous comic book reference materials to guide them in the design and execution of all of their practical mutant characters. "The executive producers from Marvel wanted to see as close a representation of the iconic comic book characters as possible," Elizalde commented. "But at the other end of the spectrum were the voices at Fox, who were thinking more practically. Their question was always, 'What can we do to retain the essence of these characters, and still translate them to the real world?'"

After a series of designs had been approved, the Spectral Motion crew moved into sculpting maquettes for each of its main characters, including Colossus. "Colossus was a known mutant character from the second film," observed Elizalde. "And, in that film, he was done as an all-CG character when he was the big, armor-plated guy. Daniel Cudmore just played him when he was a



After the opening flashback, the film cuts to the present day, with the X-Men and students from Xavier's School for Gifted Youngsters engaged in battle with robotic sentinels. The filmmakers captured most of the sequence's dynamic action on set. Shooting as many in-camera effects as possible, then augmenting them with CG, where needed, enabled Ratner to complete his film on a breakneck schedule. Digital enhancement of the sentinel battle, provided by Hydraulx, included rendering a 3D sentinel head in mental ray and distributing fog and atmospherics over the scene. As combat ceases, Logan (Hugh Jackman) inspects sentinel detritus.

flesh-and-blood human being. This time, they wanted to see if they could extend their budget by creating a background Colossus as a practical version, so they wouldn't always have to go to digital whenever he was in a scene. So we created a foam latex muscle suit covered with chrome-plated vacuform plastic, and a hard-plastic head. It really looked like it was made of metal; and the more the filmmakers saw it in the backgrounds, the more they started bringing him up to the forefront."

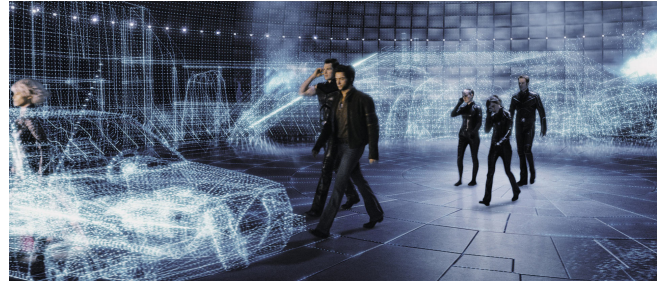
Hydraulx employed its fully-CG Colossus to tweak the suit performance. "We modified the actor's performance in the suit to create more facial expression," explained Colin Strause. "He couldn't move his mouth or anything in the helmet and mask, whereas our CG Colossus was rigged for full facial animation. We could have him screaming and yelling and doing all kinds of facial expression."

The CG Colossus also performed stunts that could not be achieved practically — but only sparingly, in deference to John Bruno's in-camera mandate. A gag in the Danger Room sequence, in which Colossus throws Wolverine 100 feet through the air — turning him into a human cannonball — became a proving ground for achieving flamboyant stunts via practical rigs. "The first test Simon Crane showed me was for this stunt in the Danger Room," recalled Bruno. "It was all done with wires and cables and cranes, using the actual actors — and it was spectacular. Colossus threw Wolverine, and that was really Hugh Jackman flying by camera."

Practical rigs were also used for a Danger Room shot of Storm flying through a series of explosions in the simulated post-apocalyptic world. "Things are blowing up all around her as she flies through the environment," said Bruno. "That was all Halle Berry on flying rigs, all in-camera. The only thing we had to do after the fact was paint out the cables."

Cinesite created the effect of the volatile battlefield dissolving to the benign Danger Room. Whereas, in the film, the scene starts in a virtual environment and transitions to a real-world one, Cinesite started with a real, live-action environment in which the actors had been filmed, and transitioned to a fully 3D one. To enable them to start the transition at any point, Cinesite artists modeled geometry that matched every element in the live-action plate. "The original idea was to transition from the live-action room to a wireframe version," noted Cinesite visual effects supervisor Sue Rowe, "to show that it was just a hologram. But, with John Bruno, we were able to push the design beyond the standard wireframe visual language of 3D and incorporate point cloud data derived from tracking software. It combined a wireframe look with a kind of x-ray effect."

"We used one of the newer features in RenderMan to create a point cloud — basically thousands of small dots in space — from the geometry data," added Cinesite CG supervisor Thrain Shadbolt. "Then we turned that point cloud data into a particle system within Maya, which allowed us to animate a particle-based disintegration of that geometry, leaving behind the fully CG environment."



The combat action is revealed to be a simulated training exercise when the battlefield dissolves to the Danger Room within Xavier's mansion and school. To create the holographic effect, Cinesite artists incorporated point cloud data derived from tracking software into wireframe geometry replicating the live-action battlefield setting. Cinesite then fed the point cloud data into a Maya particle system to animate the dissolution of the wireframe geometry, revealing the bare Danger Room — itself an all-CG environment.

It was something we hadn't tried before, but it was an interesting process that gave us quite an original look. John Bruno said he'd never seen anything like it in a movie before."

Simulated X-men battles give way to real combat when the government announces a mutant cure, developed by Worthington Laboratories from the blood of a young mutant boy named Leech (Cameron Bright), whose mutant power is to strip those around him of theirs. With the announcement, mutants gather for a protest rally in a church. The rally sequence was the first in the film to feature a wide variety of mutant characters, many of which were created practically by *Spectral Motion*. "The production asked us to come up with some background mutants," recalled Mike Elizalde, "and we must have done 300 illustrations of mutant characters by the time we were done. Of course, most of those never saw the light of day; but some of them are there in the backgrounds. Chris Evans, who was heading up the makeup department, dealt with most of that, because we had our hands full with our featured characters."



The film introduced a number of new mutant characters well known to readers of the X-Men comic books. In keeping with the in-camera approach, Ratner and team opted to create many of the genetic aberrants via makeups on performers rather than rely upon computer animation. Makeup supervisor Mike Elizalde and his Spectral Motion crew designed and executed makeups for such prominently featured mutants as Juggernaut and Beast. Company production supervisor Fernando Favila and Elizalde compare the original Beast maquette with a finished full-size head.

To fill out the rally's live characters, Soho VFX in Toronto created some partial- or all-CG mutants, such as Quill (Ken Leung). "Quill has needles that pop out of his face, head and chest," said Soho VFX creative visual effects supervisor Allan Magled. "Initially, they had done some tests with an actor wearing quill appliances; but, by doing it digitally, tracking quills to the actor, we had complete flexibility as to their position and movement." Another mutant introduced in the rally, Glob Herman — portrayed in his human form by actor Clayton Watmough — was an all-CG mutant character. "Glob Herman looks a bit like a jellyfish. His skin is transparent; and so all of his internal organs are visible."

Hydraulx also contributed mutant characters to the rally, such as a Lizard Man (Lloyd Adams) who can climb on walls and ceilings. "In some shots," stated Greg Strause, "we just added reptilian CG hands to the actor. In other shots, where he was doing more wild moves, he was all-CG. There's a shot of him in the rally where he is a full-frame 3D guy, crawling slowly across a wall."

The tone of the movie moves from the political to the personal, as the action shifts to the Xavier mansion, where Scott Summers — also known as Cyclops — is haunted by the loss of Jean Grey, and returns to the lake where she died. A mysterious disturbance in the water is followed by the sudden appearance of Jean — confused and dazed, but very much alive. The Moving Picture Company replaced the lake in the live-action footage with a CG lake to create the explosion of water signifying Jean's return. "At the beginning of this sequence," related MPC visual effects supervisor Nicolas Aithadi, "Scott takes off his sunglasses and blasts the water with his lasers — a laser effect

we created. In the next shot, the lake begins to bubble and churn. Then a whirlpool forms and grows, until finally a column of water bursts upwards and explodes in midair, creating a shockwave. We did all of that using a combination of fluid simulation and a displacement shader that we wrote. The point wasn't to do an impressive water sim, but to get a controllable template for the whirlpool and the big explosion, and to re-create, exactly, the look of the original lake."

As the reunited lovers embrace, Scott is consumed and ultimately killed by the power of the Phoenix. MPC worked with John Bruno to develop the look of Jean Grey when the Phoenix assumes control, creating hundreds of different skin and eye treatments before arriving at the final concept. "The idea was that when the dark Phoenix is taking over," explained Aithadi, "Jean's skin darkens, veining appears on her face, and her eyes go black. We went through hundreds of iterations with different degrees of darkness, with more or fewer visible veins. At the end, we went for a 'less is more' look and made the effect more subtle — but still enough to give Jean a scary look." MPC used a 3D model of Jean's face to track the digital makeup in compositing.



Actor Kelsey Grammer's transformation into Beast – an intellectual mutant diplomat – required him to wear muscle and blue fur suits and endure a daily two-hour session in the makeup chair, where Spectral Motion artists applied facial prosthetics that entirely covered his face, creating a real-life rendition of the popular character as he appears in the comic books.

Having established the dark power within Jean Grey, the film cuts to the corporate offices of Worthington Laboratories, where the mutant cure is about to be tested on Warren Worthington III (Ben Foster), whose large feathered wings have earned him the mutant name of 'Angel.' Charged with creating the practical wings worn by Foster on set, Spectral Motion went through a long design phase to determine the look and size of those wings. "We had meetings with the producers early on in the process," recalled Mike Elizalde, "and they thought it would be interesting, initially, if the wings were fairly small and lightweight — rather than giving him very large, archangel wings. So Jose Fernandez sculpted a maquette that incorporated that idea — but it was clear that it didn't look right. They looked undersized and not nearly spectacular enough. What we all agreed on, finally, were much larger wings that looked more like what you would see on an archangel. The wingspan was about 15 feet, and they measured about five feet from top to bottom.

They worked the way a real bird's wings work in that they folded in on themselves in thirds. They were made of a very lightweight foam, over which Robin Dufay and her team laid in feathers, one at a time." Spectral Motion artists lifecast Ben Foster's back so that the wings could be custom-fit and applied directly to his skin using adhesives. "We didn't have to use any harnesses or cables. The inside of the wings were contoured to fit along the contours of Ben's back. We also applied a hand-laid feather appliance at the top of the wings, to eliminate a hard edge between feathers and skin. That created a very natural blend from the wings to his back."

Rather than mechanizing the wings to execute a flying motion, Spectral Motion and production agreed that whenever the wings were fully extended and moving, they would be digital. "We didn't want to try to hide motors and mechanical devices in the wings," said Elizalde. "My attitude is — we've got digital technology, so let's use it. There's a time and a place for animatronics, but this wasn't one of them."



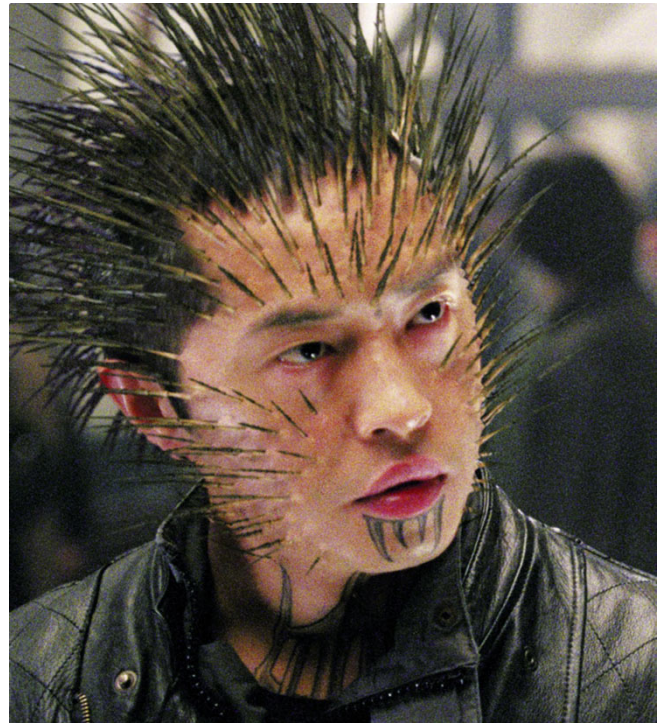
Spectral Motion also produced a suit and helmet for the massive Juggernaut (Vinnie Jones), fashioning fleshy-looking foam latex appliances for the character's muscular chest and arms.

Framestore CFC visual effects supervisor Craig Lyn executed 25 Angel shots to augment the live-action, either tracking digital wings to the actor or — for wide shots — animating and compositing a fully CG Angel. “Tracking our CG wings to the actor was fairly straightforward,” Lyn said, “but it is always a problem to have a flying human character, because it looks weird. The human body is not built to fly; so it looks unnatural, no matter what you do. Just getting Angel to look good in flight — whether it was the practical guy or our CG Angel — was tricky.”

Although Angel required some CG intervention, production achieved many of his flying scenes practically. The initial Angel flight occurs when he escapes his father’s corporate building by jumping out a window and flying over San Francisco. “This sequence was the first and biggest test of our in-camera production concept,” John Bruno commented. “Angel jumps out a 30th-floor window, flies over a crowd, across an intersection, and then flies upward into the sky. Simon Crane said he could do all of that, with the actor, using a flying rig that was programmable and computer controlled.” The sequence started with a stunt double jumping out of a window and dropping 200 feet. “Then Simon took the actual actor back up 50 feet, swung him across the intersection and crowd, and then back up over a church — all in one move.”

Whereas Angel was a new mutant in the X-Men universe, the beautiful, blue, shape-shifting Mystique was a well-established character, portrayed by Rebecca Romijn in a makeup and body prosthetics previously designed and executed by Gordon Smith. Spectral Motion created the character for *X-Men 3*, re-running silicone appliances from Smith’s original molds. “Gordon Smith sent us his molds, as well as his recipe for the appliances,” stated Mike Elizalde. “And then we ran with it. We re-sculpted a couple of smaller appliances and re-cast a few of Rebecca’s body parts; but, other than that, this Mystique was true to the original. Our team of makeup artists in Canada, headed up by Jayne Dancose, applied the makeup to Rebecca on set.”

X-Men 3 would see the iconic character destroyed by way of the mutant cure — but not before an interrogation scene in which she transforms into Magneto, then into her FBI interrogator (Anthony Heald), and finally back to her primary form as she frees herself from constraints. Kleiser-Walczak, which had perfected the Mystique transformations for both of the previous *X-Men* films, lent its expertise to the scene, which starts with Mystique provocatively leaning back in her chair as the interrogator attempts to ascertain the whereabouts of Magneto. “First, we had to shoot Rebecca



For mutant characters that could not be achieved practically, the filmmakers relied on digital solutions created in postproduction. When makeup appliance spikes affixed to performer Ken Leung failed to deliver the necessary flexibility for a mutant character named Quill, Soho VFX tracked digital porcupine-like quills to the actor. Leung sported dots on his face during live-action shooting to assist the postproduction tracking. Soho VFX also animated all-CG mutants for the show, including the transparent, jellyfish-like Glob Herman.

leaning back in the chair,” said KW visual effects supervisor Jeff Kleiser. “Then, for the transformation into Magneto, we had to shoot Ian McKellen in the same sultry pose, so we could match him to Rebecca’s position. But he said: ‘Magneto wouldn’t sit like that! She would be imitating me.’ Rather than argue with Sir Ian McKellen, I just said, ‘Okay.’ I knew we would have to figure out a way to get his upright-position body to match her body in a slouched position. Accommodating that change in posture became a 3D morphing problem. We designed the effect so that it would start at her belly and move outward; and as her belly turned into his, her body bulged out to assume his position.”

Mystique, as Magneto, then transforms into a clone of the interrogator, head-butts the real interrogator, jumps onto a table, transforms back into Mystique, performs a back-kick to knock out a guard, and then does a handspring over the interrogator. Except for a very quick cut of Mystique transforming from interrogator back into her blue form, the entire stunt sequence was achieved practically.

In a later scene, Mystique and other jailed mutants are transported in a cell-equipped 18-wheeler truck. To break Mystique and the others out of the mobile prison, Magneto uses his metal-manipulation powers to flip the truck — another gag that was achieved practically. “Simon Crane came up with a way to make an 18-wheeler do a backflip 30 or 40 feet in the air,” said Bruno. “It comes toward Magneto, he raises his hands, and it flips over his head and crashes. The trailer portion that has the cells with the mutants in them comes sliding up to him and stops.”

When one of the guards shoots at Magneto with a dart containing the mutant cure, Mystique takes the dart for him — and then does one final transformation into her human form. Looking to create a memorable Mystique send-off, Bruno conceived a transformation that was as provocative as the character herself. “I wanted to do a transition that was sexy,” Bruno said. “The character of Mystique has been all about sex; and I thought it was fitting that she go out in a sexy way. So I talked everybody into doing a shot that would push in on Mystique lying on her side; and then, as she rolled over toward camera, she would transform into the beautiful woman, Rebecca Romijn, in the nude — sans scales.”

The effects crew first filmed a prone stuntwoman wearing the blue Mystique makeup rolling onto her back, then shot Romijn — in her natural state — doing the same move. Because it was impossible for Romijn and the stuntwoman to roll in exactly the same way in the separate passes, footage of the stunt double was ultimately used only as a lighting reference, and was replaced with a computer animated Mystique. Due to time constraints and the difficulty of the other Mystique transformations, Bruno handed off some of the Kleiser-Walczak elements to CIS Hollywood. Under



Intended to be the first test subject for the mutant cure, Warren Worthington III (Ben Foster) – called ‘Angel’ because of the archangel-like wings that grow on his back – resists being injected at his father’s Worthington Laboratories headquarters in San Francisco. Spectral Motion custom-built full-size, lightweight wings and applied them to Foster’s back with adhesives, creating a blend between wings and skin with an additional, partially feathered appliance. Because the wings were not mechanized to simulate flying movements, Framestore CFC tracked digital wings to the actor in all shots in which Angel was in flight.

the guidance of visual effects supervisor Bryan Hirota, CIS animated, rendered and integrated all of the layers into a final transformation that, unlike the elegant shape-shiftings seen previously, appeared as a painful, intrusive event.

After Jean Grey leaves his care at the mansion, Xavier, accompanied by Logan and Storm, tracks her to her childhood home, intending to reestablish the mind control that will prevent the Phoenix from overtaking her. Xavier finds her alone in the living room, furniture floating around her and water from a sink flowing upward, all in reaction to her incredible power. John Bruno had conceived the zero-gravity response to the Phoenix when executives at Fox asked him to write out not only what effects would be needed and how they would be achieved, but also a back story as to how the effects related to the characters. “It was the first time a studio ever asked me to do that!” Bruno stated. “Through that process, I came up with the idea that, with the presence of the Phoenix, gravitational pull would be reversed. Water would flow upward, and objects would defy gravity.” The concept is foreshadowed in the opening flashback sequence, as the Greys’ neighbor — played by Marvel Comics creator, and one of the film’s executive producers, Stan Lee — waters his yard with a hose. “Jean, as a little girl, is being mischievous, and causes water coming from the hose to change direction and flow upward. As she gets older, it becomes a darker power, and we see this vertical water flow whenever she is upset. That is paid off at the end of the movie, when much of the San Francisco Bay goes vertical.”

Practical rigs lifted pieces of furniture and other objects for the early parts of the scene, shot in a real house in Vancouver. As Jean resists Xavier’s attempts to gain control of her mind, the zero-gravity effect intensifies and the room begins to self-destruct. “This scene begins very quietly,” observed Kurt Williams, “but it escalates to the point where it is extremely violent, with everything in the room breaking off and atomizing.”

Production shot the actors on a greenscreen stage, and The Moving Picture Company composited those elements into a CG room. “We had to re-create the whole room,” said Nicolas Aithadi, “and then progressively destroy it. There’s a shot in the sequence where a window breaks behind Jean Grey; and as soon as that happens, everything in the room, except the characters, is CG.”

MPC on-set supervisor Angela Barson traveled to Vancouver to gather photographic reference and lidar data from the location house, which MPC then used to reproduce the room via photogrammetry techniques. “Every single thing in the room — the walls, books, trinkets, every little object — was photographed from every angle and then modeled,”



Angel escapes the Worthington building by jumping out a 30-story window and taking flight over the city. Employing a programmable, computer-controlled flying rig, stunt coordinator and second unit director Simon Crane was able to create the Angel flight sequence practically, raising Ben Foster 50 feet in the air and swinging him across a San Francisco intersection, then back up over a church – all in one move. For flight sequences that could not be achieved with practical flying rigs, Framestore CFC modeled and animated a fully CG Angel.

stated Aithadi. “We wound up with 10,000 pictures, which we used to texture those models. It was a huge undertaking.”

MPC generated particle systems to simulate wind being whipped up by Jean Grey’s power, augmenting the effects of a wind machine employed on the set, and used its rigid body dynamics tool, Papi, to smash and disintegrate the 3D geometry. For a climactic — and wholly surprising — shot of Xavier being atomized, MPC disintegrated a digital double of Patrick Stewart, built from a 3D scan of the actor by Gentle Giant Studios. “We had to model every part of his body,” noted Aithadi, “as well as his shirt and jacket and trousers. Our matchmove department then roto-animated every little movement the actor did on set. They also had to roto the jacket movement, because the wind machine on set made the jacket move all over the place. Every lapel, every piece of cloth was flying in the wind; and we had to replicate all of that in CG, using camera projection techniques to reassign the texture of the jacket on him. We then used soft-body dynamics to break up everything, drawing on the model where the pieces had to detach and fly off. Once we had that, we used that soft-body dynamics simulation to atomize Xavier, starting with his clothing.”

In addition to Xavier, MPC used Gentle Giant scans to produce computer models for six other main characters — including Logan, Juggernaut (Vinnie Jones), Callisto (Dania Ramirez) and Storm — which were distributed to other vendors as needed for their specific sequences. Juggernaut and Callisto figure in the Xavier/Jean showdown, engaging Storm and Logan in a fight outside to prevent their entering the house. When the fight finally moves indoors, the Phoenix vortex lifts the characters to the ceiling — another shot achieved with practical rigs.

Initially, the only exterior suggesting the violence going on inside the house was a location shot of the real-house windows blowing out. As the scene evolved, the filmmakers determined that more dynamic exterior action was needed. “We wanted to see the house float up in the air,” stated Kurt Williams, “and we did that by re-creating the house we’d shot in Vancouver as a miniature.” New Deal Studios was engaged to deliver the shots — under the direction of supervisor Ian Hunter — by creating miniature and digital elements through final composites.

John Bruno and John Desjardin supplied Hunter with storyboards illustrating the exterior action, which had the house rising 15 feet in the air and then crashing to the ground. New Deal artists created previz based on the boards, and used photographs of the real house on location to enable Scott Schneider to build a digital house model in Rhino. “We animated the previz,” commented Hunter, “showing the house rising, showing all the shingles and debris from the top of the house coming off and swirling around, and then showing the house crashing down. Once the filmmakers bought off on the previz, we used the digital house model to generate plans to build our physical house miniature.”



Having perished at the end of X2: X-Men United, Jean Grey (Famke Janssen) reappears as a dangerous, all-powerful mutant, controlled by a dark force known as the Phoenix. Her extraordinary – and lethal – powers are violently demonstrated when Xavier tracks her to her childhood home and attempts to reestablish the mind control that will tame her inner-Phoenix. Winning the mental battle of wills, Jean telekinetically raises Xavier out of his wheelchair as the house begins to disintegrate around them.

New Deal construction crew chief Forest Fischer headed the 1/6-scale miniature build, which included the entire house and front yard, and a portion of the backyard. On New Deal's backlot, the miniature was set up against bluescreen in natural sunlight, suspended from counterweighted cables so that crewmembers could raise it manually, and rigged by New Deal mechanical effects supervisor Robert Spurlock and his crew to drop to the ground and collapse on cue. "There was a steel frame inside the miniature that was held apart by pins, keeping the house rigid," explained Hunter. "When we released those pins, the frame would collapse in on itself, and the walls and everything would be crushed. The miniature also had heavily prescored balsa wood studs and clapboard and windows, so that those pieces would collapse when the pins were released. A weak-knee made the roof break apart, as well, and we put a couple hundred pounds of weights in the ceiling of the house to help crush the walls."

New Deal also blew out the windows of the miniature, replicating the full-scale physical effect that had been shot in Canada. "The debris that came out of the house had to explode out and look dynamic, but also had to land in specific spots in the yard to match up to the existing live-action," stated Hunter. "There was glass and furniture and other debris in the yard that we had to match to." Pyrotechnician Christy Sumner executed the miniature explosion, loading pyro mortars full of broken glass and sand, which would explode out 15 feet. "Behind that, we had air cannons with cones full of larger debris — couches and books and things like that — which would fly out, followed by the glass. All of that happened in the air, as the house was elevated. A split second after the air cannons went off, the trip allowed the house to fall." Director of visual effects photography Tony Cutrono shot the miniature with a three-camera setup at 68 frames per second.

Originally, the miniature photography was to be nestled into a location plate provided by production; but when that plate never materialized, Hunter and a digital still photographer went to the neighborhood location in Vancouver to shoot a series of stills, using the camera placement in the miniature photography to determine composition. "We back-traced from where we had put the model cameras," said Hunter, "scaling up the distances by six times. Those stills became matte paintings that we put around our miniature house element."

New Deal's two-year-old digital division did the final composites for the exterior house shots, under the guidance of digital effects supervisor Anthony Riazzi, adding digital debris. "Since we'd done the previz and already had a digital house that we'd built," stated Hunter, "we were able to track the miniature house when it rose and fell. By tracking our digital house onto the miniature photography, any CG element that we added tracked in correctly. We built digital shingles, and reprojected them onto



To realize the house destruction, The Moving Picture Company surrounded greenscreen footage of Janssen and Stewart – the latter harnessed to an elevating cable rig – with an entirely synthetic interior created through photogrammetry techniques. MPC photographed every wall, book, piece of furniture and object in the live-action room – filmed in a house in Vancouver, where the production was based – from all angles, texturing computer models from that library of nearly 10,000 photographic images. MPC then used a proprietary rigid body dynamics tool to disintegrate the 3D geometry.

the digital house, which then tracked onto the model photography. Bob Chapin animated cinder blocks and two-by-fours in the basement of the house rising up and floating around in a zero-g environment. He animated shingles flying off the house and swirling around, revealing damaged roof areas underneath, which were painted by our matte painter, Dark Hoffman.”

Other digital elements included 3D characters — digital doubles for Logan, Storm, Callisto and Juggernaut — that fly out of the house at the end of the scene. “MPC provided us with those digital doubles,” stated Hunter, “which were rigged by André Bustanoby. Joel Fletcher animated them to fly out of the house and land on the road. Composer Jon Stewart then integrated the digital characters into the miniature plates, mixing them in behind rotoscoped practical debris.”

Alarmed by the potential abuse of the cure by the government, hundreds of mutants — incited by Magneto — gather in the woods to make war plans. At the encampment, Magneto tells Jean of her near limitless powers, while telekinetically lifting a metal cure gun in the air. As if to prove her superiority over the powerful Magneto, Jean disassembles the gun — a CG effect by Cinesite. “We were given the actual cure gun that they used in the shots,” recounted Sue Rowe, “and then we modeled that and animated it coming apart in a very mechanical way. We also animated the darts that remain, threaten-ing Magneto as Jean controls them.”

When Logan arrives at the encampment, looking for Jean, he is confronted by mutant guards, including Spike (Lance Gibson), aptly named for his ability to shoot lethal spikes from his wrists. Soho VFX created the shooting spikes as digital elements tracked to the actor. “The spikes shoot out of his wrists much like *Spider-Man* shoots the web out of his,” explained Allan Magled. “They shoot out into his palm; and then he snaps them off with his hand and throws them like knives. The actor had dots all over his arms and hands so we could track in our digital spikes, which looked bone-like, as if they were something organic growing inside his body.”

After a series of smaller attacks on mutant cure clinics around the country, mutant unrest escalates to a full-bore assault on Alcatraz Island, where Leech and the cure manufactured from his DNA are held under maximum security. To transport his army to the island, Magneto engages his magnetic powers, tearing the Golden Gate Bridge off its moorings and flying it across San Francisco Bay to Alcatraz. The fantastic Golden Gate Bridge action was realized entirely through a combination of full-size sets, miniatures and CG. “We weren’t allowed to shoot anything on the real Golden Gate Bridge,” explained Kurt Williams, “because the city of San Francisco didn’t want the bridge used in this way in the movie. We also couldn’t get aerial footage, because they are very restrictive about flying helicopters near the bridge. We couldn’t even get on the bridge to shoot stills!”

For live-action photography, the production crew built a full-size section of the bridge — 90 feet wide and 300 feet long — on a parking lot in Vancouver, and surrounded it with a 40-foot-tall greenscreen to allow Framestore CFC to extend the set digitally. Framestore's assignment was made far more difficult due to the fact that scheduling forced production to shoot the full-scale bridge set night-for-day, often in rainfall. "To make it look like daylight," explained John Bruno, "Dante Spinotti, the DP, set up airport runway landing lights to replicate the sun. We had a big crane come in with a cover that would swing over the actors and our hero cars to stop the rain from falling on them in the foreground. Since we were replacing everything in the distance, the rain didn't matter. Even with the big lights and the rain cover, though, these shots were really rough. When you see the final shots, it's hard to believe that they were filmed at night and in the rain — and that's all due to the great work by Framestore."

"These plates were shot in really horrible conditions," Craig Lyn confirmed. "The big lights created a lot of reflections, and we also had some spill from the giant greenscreens. There were puddles in the foregrounds and rain in the backgrounds. To make those shots look good, we had to brute-force them through massive grading, massive roto and a lot of paint work. Unfortunately, there is no 'Make the Rain Go Away' button." Framestore CFC, in addition to extending the bridge set, augmented the live-action considerably, adding digital characters to fill out the crowd of 30 to 40 extras, as well as CG cars.

For wide shots, Framestore started with photography of a 1/12-scale Golden Gate Bridge miniature shot in drier and more hospitable Southern California. With John Bruno unable to leave production in Vancouver, he handed the miniature bridge assignment to supervisor Pat McClung. "We set up a production model shop, run by Gene Rizzardi and Nick Seldon, to build this bridge," related McClung. "We shot the miniature at a medical park in Valencia, near Magic Mountain, where they shot a lot of the miniature stuff for



For exterior views of the house, New Deal Studios constructed a 1/6-scale miniature and yard. Filmed on the New Deal backlot, the miniature was manually raised on cables, and then released. Trip mechanisms timed to the house's impact with the ground made the walls and roof cave in, collapsing the structure on cue.



The setup included pyro charges to blow out the windows and air cannons to spew debris. New Deal Studios' nascent digital department used stills shot on location to create a matte-painted neighborhood surrounding the miniature.

Aviator. It happens to be up on a hill, with a big parking lot that gives you a nice, fairly clean horizon.” The final miniature measured seven feet across and 50 feet long, and was constructed of plastic and wood. “It was very intricate, with truss work underneath the bridge, all laser-cut out of very thin model aircraft plywood. We built a section of the south tower, too, which was 12 feet tall.”

Among the slated miniature shots were views of the bridge base pulling out of its moorings. “This bridge base miniature measured about 18 feet tall,” said McClung. “We cast soft-plaster pyrocel parts to give us all this crumbling debris when it pulled away. Then, Richard Stutsman, our physical effects supervisor, rigged pyro to create little explosions and things as the bridge ripped out of its base.”

To capture the specific sunset lighting that Bruno envisioned for the bridge sequence, the miniature photography crew — working under the supervision of Tony Cutrono — had only a fifteen-minute window each evening in which to shoot the miniature. “Tony and his guys were always under the gun to shoot this thing in that narrow time-frame,” McClung noted. “We shot it every day for about a month, working all day to get everything rigged for this very short shoot period at sunset.

Richard Stutsman rigged a giant crane and cables to get the movement of the bridge across the bay. That was all shot against a greenscreen, because the rest of the city was going to be put into the background later.”

Final shots of the bridge swinging across the bay toward Alcatraz — with Magneto perched at the front of the structure — and then dropping into the exercise yard of the prison were a combination of the miniature photography and Framestore CFC’s computer generated imagery. “We ended up using a bit of the miniature photography,” stated Kurt Williams, “but 90 percent of that sequence was CG. The CG allowed us to open up the shots in scope, and to show the destruction of the bridge as the moorings pulled off the land mass. CG cables snap and fly around, while the bridge hovers across the bay.”

Even the miniature shots that remained required a lot of digital enhancement, with Framestore CFC adding animated cables, CG debris, smoke and dust. Although McClung and Cutrono had shot helicopter plates in San Francisco to surround the miniature bridge, in some cases, the entire environment and sky were digital, as well. “In addition to shooting helicopter plates,” said Craig Lyn, “they had shot tiles for us, so that we wouldn’t be stuck with whatever moves they’d done in the aerial plate. We used those tiles to reconstruct the environment in some shots. For others, we shot our own backgrounds with a high-rez still camera and pieced those together.”



Enmity between the government and the agitated mutant citizenry culminates in a sequence in which Magneto leads his Brotherhood followers in an attack on Alcatraz Island, where the mutant cure is being manufactured under high security. To facilitate his troops’ advance, Magneto employs his metal-manipulating powers to rip the Golden Gate Bridge from its moorings and reposition it across San Francisco Bay to Alcatraz. Production shot live-action for the sequence on a partial full-scale bridge set in Vancouver, backing it with greenscreens to enable Framestore CFC to extend the bridge digitally.

The X-Men board the X-Jet, bound for Alcatraz to join the government in its battle against Magneto and his Brotherhood army. Cinesite's 70-plus shot count included six shots of the CG X-Jet — its initial reveal in the hangar of Xavier's school and later shots of its flying over fantastic vistas captured in production aerial plates. Originally designed and built for the earlier films by the now defunct Cinesite Los Angeles, the X-Jet underwent some minimal cosmetic alterations for this third X-Men. "The design had changed quite radically between the first film and the second," commented Thrain Shadbolt. "This time, the changes were more subtle. Rather than the matte finish the plane had in the previous movies, we gave it a bit more specularity and a metallic feel. Fortunately, given our short schedule, we were provided the original X-Jet asset to work with — so it was not a total redesign and rebuild from scratch."

Engaged in a battle with government soldiers on Alcatraz, Magneto uses automobiles stranded on the bridge as flaming projectiles, launching them over the prison yard wall as Pyro (Aaron Stanford) ignites them. Much of the car pyrotechnics was the work of the physical effects team. "Mike Vezina was actually throwing cars over our set," marveled John Bruno. "Then we extended the sequence and put in CG cars rising up and leaving frame. Anything that got too dangerously close to the actors — like when Iceman stops a car in midair, freezes it, and it falls right in front of him — was done through CG, by Weta Digital."

Weta Digital which executed 100 shots for the Alcatraz sequence, dubbed the fiery car-launching scene the 'car-be-que.' "We just had to add CG cars and generally augment the amazing stuff they shot on set," stated Weta Digital visual effects supervisor Eric Saindon. "We added digital fire and flamethrower elements for Pyro. To add to the overall destruction, we also ran rigid body simulations to blow up these cars and make them shatter as they hit the ground, or to put holes in the concrete as they smashed into walls." Weta used Massive to place additional soldiers into the car-be-que sequence.

In the middle of the chaos, a much more personal fight erupts between Pyro and Bobby/Iceman (Shawn Ashmore). "It's a classic 'fire and ice' battle," said John Bruno. "Pyro throws flames at Bobby, and he blocks them with ice. Then we see Bobby's transformation to full Iceman form — a spectacular transformation effect done by Weta."



Magneto and his mutant army cross the Golden Gate Bridge to Alcatraz, where battle is impending with troops stationed there to protect the Worthington Laboratories. Wide views of the bridge being moved, produced by Framestore CFC, featured an all-CG span composited into modified live-action plate photography or into tiled environments generated from multiple still photographs. Shots were enhanced with digital cars, debris, water splashes and dust clouds.

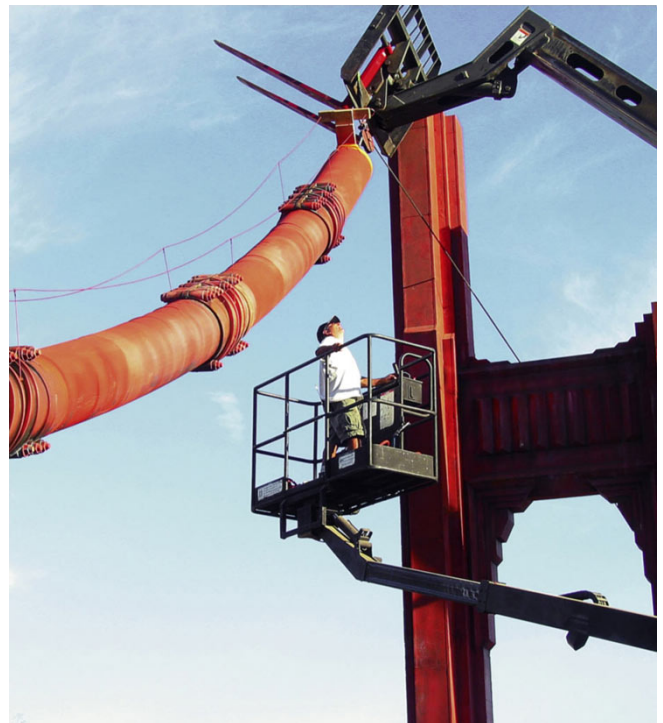
Weta created the transition from the live-action actor to a fully CG Iceman, built from a Gentle Giant Studios cyberscan of Ashmore. “We did a lot of ray-tracing to create the bubbles and opacity you see in ice,” Saindon explained. “The thicker ice is, the more opaque it becomes. Our final character looked like ice, but actually retained the character of Bobby.”

To defend against the mutant attack, the government soldiers shoot cure darts at them, instantly healing those with whom the darts make impact. One of the cured mutants is Chameleon, a character created by Soho VFX. “Chameleon is against a wall, and the wall textures are on her, making her blend in,” explained Soho VFX technical visual effects supervisor Berj Bannayan. “Then she steps away from the wall, and transforms back into her human form. For that, they had shot an actress doing a move — but they decided later that they wanted her to step out from the wall instead of walking into the scene; and so we replaced her with a completely digital version of the character. In 90 percent of the shot, she is a fully digital extra. To make her blend in, we put the wall concrete texture on her, as well as a firehose that we added to the wall to give it a bit more texture and interest. And then, our digital character steps forward and matches up to the actress’ final position. We had to do a lot of blending and creative work to make that match up.”

The cure dart healings come to an abrupt halt when Arclight (Omahyra) claps her hands and shatters the weapons. Cinesite realized the Arclight shots. “This character has a very powerful clap,” observed Sue Rowe, “which sends out a kind of sound wave of destruction. We created a rippled distortion to represent the sound wave.” In closeups and medium shots, the distortion was done as a 2D effect, whereas, in wide shots, the team used 3D particle animation. “We used soldier stand-ins for interaction with our particle effects as the shockwave goes out and disintegrates the guns,”



Some shots featured 1/12- scale bridge miniatures, built by a production model unit headed by Pat McClung. Built out of plastic and wood, the miniatures – one for closeups of the bridge base pulling out of its mounting, and the other a replica of a bridge tower – were set up on a parking lot atop a hill in Valencia, California, which provided a clean horizon. To capture the sunset lighting Ratner and Bruno sought for the scene, the miniature photography crew had only a fifteen-minute window in which to shoot each evening of its month-long schedule.



Some shots featured 1/12- scale bridge miniatures, built by a production model unit headed by Pat McClung. Built out of plastic and wood, the miniatures – one for closeups of the bridge base pulling out of its mounting, and the other a replica of a bridge tower – were set up on a parking lot atop a hill in Valencia, California, which provided a clean horizon. To capture the sunset lighting Ratner and Bruno sought for the scene, the miniature

related Thrain Shadbolt. “We also added extra shrapnel and 3D debris to those shots.”

photography crew had only a fifteen-minute window in which to shoot each evening of its month-long schedule.

Magneto takes full advantage of the temporary disarming of the soldiers, sending Juggernaut into Worthington Laboratories to find and kill Leech — forever destroying the cure. Though he would be portrayed by a digital double in some shots, Juggernaut was most often the product of Spectral Motion’s makeup effects work. “In the comic, Juggernaut is an enormous creature who wears a giant bullet-like helmet,” observed Mike Elizalde. “But to get someone to wear a helmet like that would be very difficult; and so they had to reinterpret that character into a design that could be done practically. Carlos Huante and other artists came up with 2D drawings of Juggernaut, quite a wide variety of possible designs, taking into consideration the fact that he had to retain the silhouette that everybody recognizes — this broad-shouldered, bullet-headed character. We finally arrived at a good design, which we translated to the maquette and the final makeup.”

As part of the makeup, Spectral Motion built a massive muscle suit — designed and executed by Norman Cabrera — much of which would be revealed in shots of the bare-chested Juggernaut. “It was very challenging to do a bare-chested flesh appliance that would look convincing on screen,” Elizalde said. “Fortunately, one of the members of our team is Roland Blancaflor, who is the foremost foam latex and other soft materials engineer in the world, in my opinion. He creates foam latex appliances that look translucent, like skin. So we wound up with a bare-chested suit for Juggernaut that was very realistic-looking. In fact, I remember driving up to Vinnie Jones’ trailer one day with a driver, and Vinnie was standing outside the trailer in this chest piece and an appliance to give him a very big jaw — all of which had been applied by Norman and his team. As we were driving up, I didn’t recognize that it was Vinnie, at first; and I remember thinking, ‘My God, that guy is huge!’ The driver mentioned it, too — ‘Look at the size of that guy! He’s enormous!’ It was just Vinnie in this suit; but, for a moment, we both thought he was a real guy.”

To fulfill his murderous assignment, Juggernaut smashes through walls within the Worthington facility as Kitty Pryde (Ellen Page) phases through them, racing to reach the boy first and save him. CIS Hollywood realized the sequence. “The production had shot a couple of different sets,” related Bryan Hirota. “One was for the beginning, when Kitty uses her phasing powers to imbed Juggernaut waist-deep in the floor. They had a set with an open floor and a hydraulic lift that lowered the actors into the floor as they were fighting. Then we filled in the open area with a CG floor, and matchmoved the camera and Juggernaut and Kitty, building proxy objects for them so that we could create CG reflections and shadows.”

Juggernaut bursts out of the floor and chases Kitty, crashing through walls. “For shots of them running through the walls,” said Hirota, “the production art department built set walls with holes in them, and the actors just ran through them. Then we added CG wall to close up those holes.” CIS also digitally manipulated the live-action to create a subtle phasing effect. “We’d seen Kitty phasing through things in the last *X-Men* movie, and they pretty much wanted that same look this time. Nothing happens to Kitty’s body when she phases through; but there is a slight warping around her that happens in the wall, which was just a 2D distortion effect that we did.”

To sell the effect of Juggernaut crashing through the structures, production had shot dust and tiny bits of debris out of air cannons at each point where the character would impact a wall. “We had to matchmove all of that and create CG walls that were prescored,” Hirota explained. “When we ran our matchmoved Juggernaut through the wall, the rigid body dynamics caused the wall to break apart, revealing the preconstructed hole in the set wall.”

Outside the lab, hostilities appear to come to a halt when government ambassador Dr. Hank McCoy (Kelsey Grammer) — also known as Beast — leaps out of the fog and stabs Magneto with a cure dart. Spectral Motion executed the Beast costume and



To reinforce the embattled troops at Alcatraz, the X-Men depart Xavier’s mansion in the X-Jet. Cinesite executed all of the X-Jet shots in the movie, starting with the digital model built by the now-closed Cinesite Los Angeles for X2: X-Men United. Though the filmmakers did not wish to

makeup, basing the makeup on a drawing by concept illustrator Constantine Sekeris. “That drawing really won everybody over,” recalled Mike Elizalde. “Beast is a highly recognizable figure in the X-Men comic book world, and we had to figure out a way to bring all of those recognizable features into this makeup. He is blue and furry, but he is also highly intelligent. We wanted to take as many features from the comic book character as we could, and then translate those to Kelsey Grammer’s face.”

Once the studio and the filmmakers had approved a maquette and a makeup tested on a crewmember, Spectral Motion artist Motoyoshi Hata sculpted the makeup appliances on a Kelsey Grammer lifecast. “The makeup consisted of a cowl piece that included the ears,” explained Elizalde, “plus a forehead appliance and a wraparound horseshoe appliance that covered the chin and cheeks. There were upper and lower lip and nose appliances, as well. So his face was completely covered, and he was all blue. We even tinted blue the pink part around his eyes, where the eye-lashes connect.” After two hours in the makeup chair, Grammer donned a muscle suit sculpted by Mario Torres, covered with a hand-punched fur suit to give him an appropriately muscular and furry Beast form.

Soho VFX animated a CG character for the shot of Beast leaping out of the fog toward Magneto. “Part of his character is that he does all of these spectacular leaps and jumps that a real person couldn’t do,” said Allan Magled. To build the CG character, Soho VFX started with a Gentle Giant scan of Grammer in costume and makeup. “Scans don’t read hair very well, and Beast is a very hairy character; so that was just a rough template. We had to do a lot of work to create the final character.”

“We used the latest version of the in-house fur tool we’ve been developing since we started,” elaborated Berj Bannayan, “the same tool we used on *The Chronicles of Narnia* for the fawn, satyr and centaur bodies. We tweaked it a bit for Beast, and then went through our normal combing and shading process that we’ve perfected over the last few years to give Beast the right look.”

With Magneto incapacitated, the battle appears to be over — until Jean Grey, in full Phoenix mode, begins atomizing soldiers and destroying everything on Alcatraz Island. Other than live-action footage of Famke Janssen, shot on a debris pile set against greenscreen, everything in the destruction sequence was CG, created by Weta Digital. “For us to destroy Alcatraz,” explained Eric Saindon, “we first had to build it in CG. Just about everything in those shots — buildings, walls, debris — was CG. We even had to change the look of Jean Grey in the plates, because we had to give her black eyes and a subsurface glow to indicate that the Phoenix has taken her over.”

alter the design of the plane for the third film, Cinesite updated its look subtly, giving its original matte finish a more reflective, specular and metallic sheen. For the liftoff shots, Cinesite composited the digital plane into location plates filmed at Royal Roads College on Vancouver Island.



The arrival of the Brotherhood army on Alcatraz is followed by a sequence in which Magneto uses his powers to launch disabled cars over the prison yard wall as Pyro (Aaron Stanford) ignites them, transforming the vehicles into flaming projectiles. Mike Vezina’s physical effects team orchestrated much of the action, catapulting real cars over the set wall. More dynamic shots – or car stunts that would have endangered the cast and crew – fell to Weta Digital, which added CG cars and fire to the scene, as well as characters created in Massive.



Alcatraz is hastily evacuated when Jean Grey, as the Phoenix, starts destroying every being and structure on the island. Only Logan, whose regenerative powers make him immune to her murderous assault, remains behind to kill the Phoenix – and thus, save Jean – slowly making his way to the top of a debris pile on which she stands, surrounded by the carnage she has wrought. Famke Janssen and Hugh Jackman enacted the scene on a sparse set surrounded by greenscreen to accommodate digital extensions provided by Weta Digital.



In the final composite, Weta Digital artists added CG charred cars and rubble to backgrounds to extend the debris pile set, and also incorporated digital fire and smoke elements. To indicate the total transformation of Jean into the dark Phoenix, Weta altered Janssen's look in the greenscreen photography, blackening her eyes and giving her a luminescent subsurface glow.

To proceduralize the destructive shockwaves emanating from Grey, Weta developed software that could transform any piece of geometry into particles at a predetermined point. “Say a wave comes out and goes through a car door,” explained Saindon. “Our procedure would turn that car door into particles that then just blow away like dust. We did the same thing with soldiers or anything else that had to be atomized.”

At one point in the finale, time seems to stand still as the camera moves around Jean and the destruction surrounding her. The design of the 20-second frozen-time shot was informed by John Desjardin, who had realized a similar — and much admired — shot for Swordfish. “We wanted to do the most elaborate version of this kind of shot anybody had ever seen,” John Bruno remarked. “Not

only do we go inside the blast, where soldiers and structures are atomizing, we also see a wave from Jean Grey blow out the back side of the island, knocking out what is left of the prison.”

Weta simulated a camera speed of 150 frames per second in the all-CG bullet-time shot, slowing down the action enough to make the digital shockwave read. “It was all a virtual move,” commented Saindon. “We went in very close to Jean Grey in the plate, and then pulled back in 2D to re-create the bullet-time effect. This is supposed to be her biggest wave yet; and it is so powerful, it shoots the water from the San Francisco Bay upward. There are a couple of wide shots in which we had to simulate water rising and forming a tube around Alcatraz.”

In reaction to the violence, everyone evacuates the island — except Logan, who remains behind to do what he must do. “Logan realizes that because Jean has been completely taken over by the Phoenix,” said Kurt Williams, “he has to kill her in order to save her. So he begins to climb the pile of debris Jean is standing on; and as he moves toward her, she atomizes him. But, because of Logan’s rejuvenation powers, he heals himself immediately. She continually atomizes him, his body is torn apart, down to his skeleton, and then it heals back.”

“This is basically Logan’s trip through Hell,” John Bruno added. “Everything is on fire, the water in the bay is rising vertically, half a mile into the sky, and he is being atomized and regrowing, over and over again. As he is moving up, first his clothes rip away, then we take him down to his adamantium skeleton. When we first did it, he looked too much like the *Terminator*, and everybody said, ‘Oh, no, back up!’”

Weta Digital executed the atomizing and healing effect, digitally ripping off Logan’s skin to the bone and then growing it back. “Rather than try to re-create a digital version of him that would hold up in all of these shots,” noted Eric Saindon, “we found it easier to track in 3D digital wounds.” Logan finally makes it to the top of the debris pile, where — after confessing to Jean that he loves her — he extends his claws and mortally stabs her.

“This final sequence is unbelievably intense,” said Bruno. “It is 80 remarkable, full-on CG shots. They are an incredible technical achievement that really show what Weta can do.”

The film’s epilogue is a memorial service at Xavier’s school, where Storm now serves as headmistress. In a long, final pullback, the camera starts on Logan walking out of the mansion, onto a veranda, and then rises high above the grounds. To create a more beautiful, green expanse in a helicopter aerial plate that had been shot in the winter, Hydraulx artists replaced the live-action terrain with a traveling 3D matte painting. That shot then dissolves to images of Angel flying over San Francisco and the Golden Gate Bridge, now under new construction — shots based on Ansel Adams’ 1937 photographs of the original bridge being built. Finally, the camera moves to Golden Gate Park, where Magneto — stripped of his mutant magnetic powers — attempts to move a chess piece telekinetically.

It was only through the collaborative efforts of literally hundreds of visual effects artists that the 900 effects shots mandated by *X-Men 3*’s ambitious storyline made their way to the screen in time for the film’s Memorial Day Weekend release. The production’s excruciatingly tight schedule had made for seat-of-the-pants filmmaking that was, despite its stresses, exhilarating and highly

creative. "I've never before experienced a show quite like this one," concluded John Bruno. "Everything about it was exciting, innovative and new."

X-Men: The Last Stand photographs copyright © 2006 by Twentieth Century Fox. All rights reserved. Production still photography by Kerry Hayes. Additional photos courtesy of Pat McClung and Spectral Motion. Special thanks to Steve Newman, Laura Howe, Michael Broidy, Sophie Trainor, Helen Arnold, Steph Bruning, Danielle Birch, Taryn Kelly, Robin Dicker and Amanda Roth.

A Hero's Return

ARTICLE BY JOE FORDHAM

In Action Comics #1, dated June 1938, creators Jerome Siegel and Joe Shuster ushered in a new breed of comic book character — an unlikely hero of alien origin who fought crime wearing red boots, blue tights, red shorts and cape.

In 1978, movie moguls Ilya and Alexander Salkind produced *Superman: The Movie*, the first feature film built around the D.C. Comics icon. Director Richard Donner structured the lavish production with a prologue on planet Krypton featuring Marlon Brando as white-haired scientist Jor-El, who saves his baby son, Kal-El, by rocketing the infant to earth before Krypton is destroyed. An elegiac first act established *Superman's* formative years in rural Smallville, Kansas, where earth's sun imbued Kal-El with superhero abilities. This was followed by the main body of the adventure in 'Metropolis,' where the adult *Superman* (Christopher Reeve) adopted an alter ego as bumbling reporter Clark Kent, clandestinely fighting crime as the 'Man of Steel.' The film won an Academy Award for its visual effects, which included flying scenes achieved by computer-controlled front-projection rigs devised by visual effects cinematographers Denys Coop and Zoran Perisic. British effects veterans Les Bowie, Colin Chilvers, Derek Meddings, Roy Field and Wally Veevers executed wirework, mechanical effects, miniatures and opticals.

After three sequels, the *Superman* series lapsed into development limbo as filmmakers strove to inject new life into the franchise. In 1993, Warner Brothers and director Tim Burton explored a revisionist approach. Burton's take involved Nicolas Cage as a brooding gothic Clark Kent battling alien invaders in a glittering translucent *Superman* costume prototyped by creature effects maker Steve Johnson. Concepts failed to gel, but the source material continued to attract a revolving door of directors, including Oliver Stone, Wolfgang Petersen, Brett Ratner and Joseph 'McG' McNichol. McG's adaptation gathered momentum with a more utilitarian approach to the *Superman* suit, reworked at Stan Winston Studio as sleek body armor, while visual effects supervisor Boyd Shermis and visual effects producer Rhonda Gunner developed previzualizations and visual effects tests. Script issues again halted production, until director Bryan Singer stepped into the breach in 2004, launching Warner Brothers' and Legendary Pictures' *Superman Returns*.

Singer's take on the material was rooted in a formative viewing experience in December 1978. "I saw Richard Donner's *Superman* on opening night with my mother at the Prince Theatre on Route 1 in New Jersey," Singer recalled. "The movie brought a great reality to a superhero story, and it ended up serving as a guide when I directed *X-Men*. In fact, I had a five-hour bootleg cut of *Superman: The Movie*, with a lot of deleted scenes gathered together on a tape, and we watched that quite often on the set of *X-Men*. That very real treatment of a superhero mythology informed my approach to both *X-Men* movies, and ultimately to this *Superman* movie."

The screenplay, written by Michael Dougherty and Dan Harris in collaboration with Singer, took *Superman's* origins as a given and brought the hero back to earth after a six-year absence seeking traces of his off-world origins. After a brief stopover in Smallville, Kal-El (Brandon Routh) comes to terms with his new place in the world and returns to life as Daily Planet reporter Clark Kent, where his long-suffering love interest, Lois Lane (Kate Bosworth), now has a child and a new relationship with her editor's son, Richard White (James Marsden). The reappearance of an old nemesis, Lex Luthor (Kevin Spacey), and the theft of a shard of kryptonite cause *Superman* to resume his role as protector of the peace, while Luthor attempts to exploit Kryptonian technology.

The project took inspiration from Richard Donner's film in the classic look of *Superman's* livery, which Singer's longtime wardrobe designer Louise Mingenbach designed in the familiar blue and red, with only minor concessions to textile tone and technology. "*Superman* has existed in roughly the same style and color palette for far longer than I have been on this earth," observed Singer. "It was not my place to mess with it too much. We did, however, alter a few things to make the costume more seamless on screen. We removed the 'S' from his cape, and we raised the 'S' on his chest into a three-dimensional shape, which made it very powerful when light reflected or cast shadows across the bevel."

Other key collaborators from earlier Singer films were cinematographer Thomas Sigel, production designer Guy Dyas and visual effects producer Joyce Cox, joined by visual effects supervisor Mark Stetson, with whom Singer had been developing a remake of the science fiction film *Logan's Run*. Working under the banner 'Red Sun Productions,' the team reviewed existing previz and story concepts, and then started from scratch with a new round of previsualization at Pixel Liberation Front. PLF executive producer Sean Cushing installed a team of approximately a dozen artists, led by Chris Batty and Kyle Robinson. Batty, Robinson and two additional lead artists later joined the production at Fox Studios Australia in Sydney, where local effects vendor Rising Sun Pictures helped outfit the group to bring the previz team to 16. "People were stunned the previz looked so good," commented Mark Stetson, "but we really couldn't show Bryan any less. He was using previz to present sequences to the studio, so he had us go all-out with detail."

The detailed animatics set a benchmark for the design of shots, which were spread across ten visual effects vendors on three continents. Production chose Sony Pictures Imageworks to lead development of a *Superman* digital double and key action set pieces, capitalizing on the studio's experience in two *Spider-Man* movies. All vendors used Rising Sun Research's cineSync, a multi-platform file-sharing infrastructure, to share ideas and tools in online forums. "We had QuickTimes of effects shots, cut sequences or jpegs in folders on our computers at Red Sun," Joyce Cox explained. "The vendors had the same material in folders on their side; so we could bring shots up in sync, watch playback with sound, and Mark could stop the image, draw on it, and say, 'Move this to the left, make this more gray...' That enabled us to manage more than 500 shots out of the country."

Parallel with digital development, the filmmakers explored physical effects to simulate *Superman's* ability to fly. As soon as Brandon Routh was cast as the *Man of Steel* in November 2004, the performer embarked on rigorous physical training to condition him for wirework. "The first time I hung Brandon in a wire rig," remarked stunt coordinator R.A. Rondell, "his reaction was just what I expected — pure pain! I told him from the beginning, 'You're going to hate me, and you're going to hate these rigs; but I'm going to teach you to tolerate it.' I didn't want to give him false impressions that it was going to be comfortable. We've come a long way with making flying rigs as user-friendly as possible, but they're never comfortable. Brandon did a lot of core training — inner strength work, back extensions, stomach crunches and abdominal work — to help him hold horizontal flying postures and make the wire rigs tolerable."

Rondell commissioned Todd Rentschler of Climbing Sutra in Las Vegas to design and fabricate flying harnesses worn beneath a muscle suit. The largest harness encased Routh in a vest extending to just above the pelvic bone, with straps that wrapped underneath the groin. For vertical flight, takeoffs and landings, harnesses had two-inch webbing straps that crossed around the crotch like a diaper. For flipping and turning, Routh wore harnesses that wrapped across his hips, with lateral attachment points.

Overhead flying rigs ranged from two parallel 1,000-foot-long high-lines suspended from cranes on location to an enormous overhead gantry erected on Stage 7 at the Fox studio. Zero-G Action Rigging Specialists, having previously worked with Rondell on the *Matrix* sequels, designed and constructed the gantry rig — a giant grid with two tracks of wires for travel from point A to point B. Zero-G programmed motorized cable winches for speed, height and duration, but generally operated the rig by hand. "Controlling wire rigs manually allowed us to make corrections right away if a subject found himself in the wrong position, or something unpredictable happened," said Rondell.

Airborne shots were photographed at Fox Studios against greenscreen, utilizing either the wire flying harnesses or a computer-controlled motion base developed by special effects supervisor Neil Corbould. "We called it a 'quadra' rig," explained Corbould. "It was a sickle-shape device that could tilt Brandon up and down on three axes of movement and rotate 360 degrees. We hand-operated it with a little waldo, then recorded each move for playback."



Nineteen years after his last cinematic appearance, D.C. Comics' Man of Steel (Brandon Routh), valiant survivor of the exploded planet Krypton, returns to theater screens in Superman Returns. Directed by Bryan Singer, the new film conveys Superman's superpowers through the use of physical effects supervised by Neil Corbould, stunt work orchestrated by R.A. Rondell and visual effects supervised by Mark Stetson. Visual effects vendors on three continents contributed to the massive production.



Routh lay in the motion base either on his stomach or back, supported by a thin carbon fiber body fitted beneath his muscle suit. The rigid body mold was connected to a pole arm attached to the multi-axis rig. Previz guided rig and camera choreography, while puppeteers clad in greenscreen bodysuits manipulated Routh's cape with cables and air movers.

Returning to earth after a six-year absence, Superman recalls his years as young Clark Kent (Stephan Bender) coming to terms with his superpowers while growing up in rural Kansas. Rising Sun Pictures handled digital effects for the Smallville scenes, which the production filmed on location in Australia, north of its main base of operations in Sydney. Depicting the boy's superpowers required stunt rigging, mechanical effects and a digital re-creation of Bender generated using photographic textures of the actor, subsurface scattering skin shaders, digital cloth and hair simulations.

Motion coach Terry Notary, a former UCLA gymnast, worked with Routh to help develop flying styles for physical and visual effects. "Even though we wanted to do some flying shots digitally," said Mark Stetson, "we often shot a wire flying simulation to get a sense of how *Superman* moved. We shot some preliminary motion capture tests with Brandon and studied the practical wire-flying work; and then Sony developed tests to extend that performance."

Imageworks launched a six-month research and development period for its digital *Superman* shortly after Routh was cast. "We knew Brandon would not have his finished costume or hairstyle," commented Stetson, "nor would his body be in its finished state. But we scanned him and started analyzing his motion, and then did everything again in April 2005, when we started shooting. That worked out pretty well, because, by the time we started shooting, Sony was able to demonstrate what they could do with the digital *Superman*. That helped us figure out what shots we would need to shoot greenscreen, and what we could happily pass off to digital."

Early digital studies included photography, scanning and image-based modeling and rendering surveys done at the University of Southern California's Institute for Creative Technologies' Light Stage. Routh wore a rough approximation of the classic *Superman* costume, and was surrounded by six cameras whose shutters were synchronized to a rotating arc of strobe lights that swept around him, illuminating 480 skin texture samples in each seven-second pass. "We used two more Light Stage cameras than they had used on *Spider-Man 2*," commented Imageworks visual effects supervisor Richard Hoover. "That helped us capture more of Brandon's performance simultaneously. We refined shaders to extract highlights and skin sheen from the textures of his face, which is generally the most difficult part of the image-based rendering process. We also built a facial animation system, enabling the character to perform dialogue with a range of phonemes and vowels."

Imageworks CG supervisor John Monos headed research and development of the CG *Superman*, while lead digital artist Todd Taylor set up the muscle deformation rig for the character, and lead technical director Jake Rowell and character lead Thelvin Cabezas detailed muscle shaping and suit dynamics. Rowell mapped Light Stage imagery to the 3D model, processing data from several thousand still images in order to reproduce a three-dimensional photorealistic representation of Routh's skin reflectance. "The highlights and diffuse illumination of the skin were all contained in one photograph," explained Monos. "As the Light Stage rig moved around him, highlights traveled across his face, seen from six stationary cameras. It took a lot of work to create transitions from one set of images to the next, and to make the highlights appear to travel correctly on our model. Technical director Cory McMahon developed an algorithm to separate highlights from the diffuse illumination. Jake Rowell then finessed the algorithm output to retain the sharpness of the image to keep it as close as possible to the actor."

Animation supervisor Andy Jones developed four test shots of the digital *Superman* in action, and a test of the digital double's lip-sync abilities known as the 'My Name Is Bob' shot. "We were originally going to shoot a closeup of Brandon in character as *Superman* reciting a line from the movie," recalled Mark Stetson, "but Bryan, at the last minute, thought: 'I don't want to do that! What happens if it leaks?' So he had him recite a nonsense line: 'Hello, my name is Bob, and I'm here to fight for Truth, Justice and the American Way.' Sony then matched that closeup, projected side by side with the original."

Richard Donner's film also informed the animation tests. "Bryan Singer asked us to study Christopher Reeve's flying poses," explained Andy Jones. "Brandon studied them, as well, for his movements on the greenscreen stage. We saw that Christopher Reeve had both arms forward in fists if he had to get somewhere fast, or if he was angry. For more leisurely flying, he used less of a fist. He dropped one arm down to turn, using his left arm to bank left and his right arm to turn right. For subtler flying, he would sometimes put one knee down, as if he was enjoying flight."

To develop facial animation, digital effects supervisor Alberto Menache built on technology developed for *The Polar Express*, employing an internal facial muscle system that consisted of a library of approximately 70 facial expressions derived from motion capture converted into muscle shapes. Animators interpolated facial poses using blend shapes for long shots and more specific expressions for closeups. Body motion was entirely keyframe-animated.



To capture Clark's exhilarated run and vaulting leaps across a cornfield, R.A. Rondell's stunt team created practical performances with Bender on location, via wire rigs and stunt harnesses. After previsualizing and rehearsing at Fox Studios Australia, in Sydney, the production relocated to a five-acre cornfield where stunt and camera teams erected 150-foot-tall cranes to suspend the 15-year-old actor and a remotely operated Panavision Genesis camera in 1,000-foot-long wire runs. Rising Sun Pictures generated cornfield extensions and rig removals, and used the digital double for shots of young Clark leaping beyond the reach of stunt rigging.

Superman's majestic flowing red cape also became an expressive part of the character. Wardrobe artists employed a variety of materials to produce capes for flying and standing configurations. The main cape consisted of a semicircle of textured crimson vinyl, poured from a large one-piece mold, then lined with vibrant red silk. Cut straight across the middle, the cape gathered and hung around Routh's shoulders. Imageworks used samples of cape material and took reference photographs of digital artist James Part modeling the garment on Imageworks' roof. John Monos' team used the textures to create a digital cloth shader that emulated the cape's detailed look, while Andy Jones devised cape animation working closely with Girard Banel, president of cloth simulation specialists SyFlex Studio. "The cape had to create a great flowing feeling," observed Jones, "yet it had to be flexible enough that we could shape it and stylize it from shot to shot. SyFlex had great wind simulation tools, and it gave us a lot of control to make the cape hit certain poses at certain times, while keeping a natural motion."

Imageworks digital artist Takashi Kuribayashi created wind simulations that maintained the cape's graceful character despite extreme velocities. "We did some early experiments of wind dynamics distorting *Superman's* cape and face at high speed," related John Monos. "But what really happens to a cape in high speed — like a flag flapping around violently in a hurricane — was not what the filmmakers wanted. It became an issue of maintaining the cape's aesthetic sensibility while capturing a sense of speed." Imageworks applied cape dynamics with the understanding that all materials were of superhero origins, and developed CG shading and grooming styles for *Superman's* heavily pomaded hair and trademark 'kiss curl' in a similar vein. "They put so many hair products on Brandon's hair on set," observed Alberto Menache, "his hair didn't move at all! We did our own tests with different densities and rigidities of CG hairdos, studied how they moved when he was flying at high speed, and animated the hair to move like it was in a breeze."



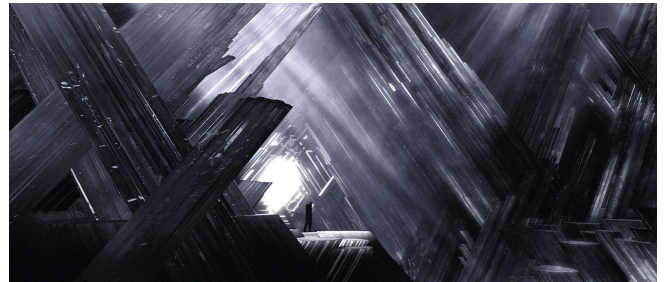
Superman's nemesis, Lex Luthor (Kevin Spacey), journeys toward the *Man of Steel's* arctic hideaway, the Fortress of Solitude. The production filmed arctic scenes on soundstage sets at the studio. Rhythm & Hues produced arctic set extensions and environments using painted and scenic textures projected onto 3D geometry. Photon VFX constructed miniature versions of Luthor's palatial yacht, the *Gertrude*, but when script revisions dictated design changes, Rhythm & Hues generated the vessel digitally and integrated it into CG ocean environments.

Although it was not included in the theatrical release, the original opening sequence of the movie had the *Man of Steel* visiting the remnants of planet Krypton. The sequence took a visual cue from production designer John Barry, who, for the 1978 film, had depicted *Superman's* home world and arctic refuge on earth as soaring crystalline structures grown from frozen environments. "The crystal structures that John Barry designed for Krypton and for the Fortress of Solitude were vitally important to the design of our movie," asserted Mark Stetson. "The crystal theme threaded through our story — it was the 'McGuffin' that Lex Luthor seeks to overpower *Superman*, and it was vitally important to effects sequences that followed."

To explore techniques for digitally modeling crystal structures, the production consulted with Frantic Films, a visual effects facility with offices in Canada, Los Angeles and Sydney, which had produced digital crystal imagery for *The Core* and had also created previsualizations and digital kryptonite tests for McG's *Superman*. Frantic built a base of research — shared by several effects facilities on the film — that included a crystal growth application written by technical director Borislav Petrov for Autodesk's 3ds Max. "We could take any CG model," said Frantic Films visual effects supervisor Chris Bond, "fill that model with crystal, and then animate keyframes to grow in whatever shapes we wanted. It allowed us to very quickly prototype crystal props and environments. We used that to create conceptual illustrations in 3D, which the art department then built as miniatures or sets."

Frantic rendered multi-faceted translucent kryptonite using Splutterfish's Brazil software. "We needed a powerful ray-tracer to render millions of polygons with refractive layers," stated Bond. "We did a lot of research and development with internal refraction, using high dynamic range imagery shot at our various offices — a snowfield in Winnipeg, the ocean in L.A. — and studied how the crystals reflected and refracted the environments. Brazil handled ray-tracing very efficiently and made the crystals look deep and refractive, taking on the colors of the environment." Frantic's crystal work continued a collaboration with the late computer graphics artist Richard 'Doctor' Baily, whose high-resolution particle animation renderer, Spore, filled kryptonite's internal geometry with swirling psychedelic light sculptures. "Doctor Baily provided us with Spore characters. We produced tools to render, reflect, refract, stretch, warp, twist and fit them to a volume. Our renderer could cast the Spore data to other renderers, and gave us the ability to give life to kryptonite in a unique visual way."

In the deleted opening, *Superman* travels to his home planet in a crystal starship resembling John Barry's 1978 design. Frantic employed the crystal growth application to model the ship exteriors and an expanse of drifting crystal debris. "Mark Stetson asked us to avoid traditional 'baked potato' asteroid shapes," remarked Bond. "They had to be sharp and jagged, detailed and crystalline. It was a tremendous rendering challenge." Frantic lighting and rendering director Jeremy Butell and digital artist Marcus Steeds generated 20 classifications of crystals. "We had chunks from the size of a golf ball to the size of Manhattan. We then decided which ones we wanted where, and made different scale versions of each family." Frantic integrated Spore through several thousand chunks. Distant crystals contained Spore ephemera pre-rendered onto cards, while closer pieces contained elements rendered in 3D.



Luthor enters the Fortress of Solitude. The environment took a visual cue from the production design of Richard Donner's 1978 Superman: The Movie, which depicted Superman's home world and its technology as soaring crystalline structures grown from frozen environments. For Bryan Singer's film, production designer Guy Dyas crafted a partial set of the Fortress interior that reached to the studio rafters. Rhythm & Hues generated exterior views and expanded the interior set with digital extensions.

The sequence included views of *Superman* emerging from his sleep pod to see the horizon of Krypton, which appears intact until the camera pulls back to reveal the ship perched on only a shard of the planet. Photon VFX in Queensland, Australia, generated the planet surfaces using miniatures ranging from 1/20- to approximately 1/2,000-scale. Modelmakers built large scenic expanses out of timber, styrene, glass and metal molded with sprayed polyurethane, and detailed architectural areas with styrene sheeting. For geology subject to close scrutiny, modelmakers built real crystals into the landscape.

To create depth of field on smaller-scale miniatures, Photon visual effects cinematographer Steve Newman shot exposures of up to two seconds per frame. Early tests, however, shot on 35mm film, produced noticeable grain compared to dailies produced with Panavision's Genesis camera system — a high-definition digital camera making its theatrical debut on the film. In one of many production firsts, Photon visual effects supervisor Dale Duguid and sequence supervisor John Breslin adapted the Genesis camera to a Milo motion control rig. "We developed electronics to synchronize the Genesis frame rate on each multiple pass," Duguid explained. "It was not a proprietary component for the camera at that time, so we had to literally invent it — in the space of 48 hours. The real challenge was to get Genesis to absorb light at a slow shutter speed without introducing electronic 'noise' into the image. Generally, the longer you expose an electronic camera chip, the more noise you get — the exact opposite of film."

Photon countered for the effects of a light-depleting snorkel lens and matched the sensitivity of 500 ASA film by adjusting the Genesis electronic shutter to 350 degrees and 'frame blending' to aggregate a frame every eight frames. "In theory, it was impossible," said Duguid. "But Panavision's digital imaging manager, John Virtue, gave us insights into the Genesis' potential, and we made it work together. We piggybacked a second 100K Soft Sun lamp on top of our first one, slowed the move to half-speed and gained an extra stop. It felt like we were the Apollo 13 team at NASA finding out their spacecraft was crippled halfway to the moon. But we demonstrated the system could deliver a result, and then got on with the shoot."

The Genesis rig enabled Photon to shoot motion control matte passes, beauty passes, highlight and interactive light passes, and it allowed for instant playback of 'style frames' captured into an Apple G5 and assembled on set by Photon 2D artists. "It was wonderful to have real-time dailies," said Duguid. "Coming from a film background, there's a stigma that no other format will ever be as good. But I must say, when we had our 30-inch Apple monitor on set, and ten seconds after shooting we could see our shot at almost full fidelity, it took about three minutes for everybody to become electronic camera devotees!"



*Luthor discovers a control panel and activates a glowing hologram of Superman's father, Jor-El, embedded in crystal. The production filmed Kevin Spacey on a raised section of the set, built from translucent materials. Rhythm & Hues digitally rebuilt the control panel to grow around Spacey, and generated Jor-El's image using archival footage of the late Marlon Brando shot for the 1978 *Superman* film. Digital artists built a 3D facial likeness of Brando, tracked in footage of the actor's Jor-El performance from the nose up, and re-animated the mouth, blending synthetic and painted textures.*

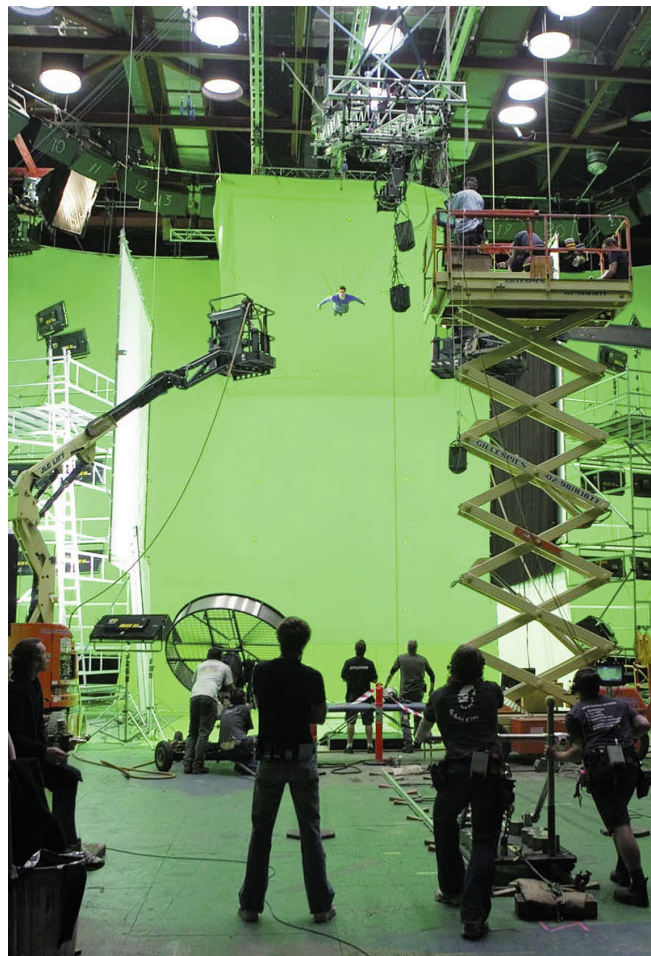
Kal-El journeys to earth, crash-landing near Smallville, where he recalls his days as young Clark Kent (Stephan Bender) coming to terms with his powers. Production filmed the sequence 260 miles north of Sydney, in Tamworth, where the Genesis camera received a baptism of fire. “In the first week of shooting,” recalled Mark Stetson, “we were on location in 100-degree weather, flying this brand new camera on giant wire rigs, with R.A. Rondell flying our 15-year-old actor over cornfields. It was crazy stuff — flying through sprinklers, finding out the camera hated water, it hated heat — and initially we had only two speeds: 24 frames per second and ‘off!’”

The Genesis camera nevertheless captured pristine digital imagery using the identical Panavision film camera lenses used for Singer’s Apt Pupil and X-Men 2. The Tamworth shoot included full-scale sets of the Kent farm and a five-acre plot of corn planted for the film, used for extensive in-camera stunt work.

Rehearsals and previsualization guided placement of 150-foot-tall cranes for 1,000-foot wire runs, which supported the performer’s weight, hauling him along

at 20 miles per hour as the actor mimed running in slow motion. “We had the capability of running up to 45 miles per hour,” noted R.A. Rondell, “but it became too unbelievable at a certain speed. I tried to keep it to a pace where Stephan could make contact with the ground, so he had some gravity and his postures were correct as he left the ground, jumping and landing.”

A spectacular practical, in-camera shot captured young Clark’s exhilarated leap through sprinklers backlit by the sun. Rising Sun Pictures retained the natural camera move and lens flare, then rebuilt the shot using a CG sprinkler spray, clouds and digital corn extensions, and a CG double of the actor. “We started the ball rolling using a low-rez 3D dummy projected with footage of the actor,” stated Rising Sun visual effects supervisor Tim Crosbie. “That allowed us to tweak his limbs by up to 20 percent and gave our animators a good head start.” Lead artist Daniel Kripac then built a high-quality digital double of young Clark — generated using photographic textures of the performer, subsurface scattering skin shaders, Maya cloth and hair simulations — seen in the sprinkler shot and other shots of the character leaping beyond the reach of stunt rigging. Closeups featured head replacements, using greenscreen elements of Stephan Bender tracked to the digital model. Wide shots featured digital environment extensions using 3D corn and bluescreen plates of cornstalks pasted onto digital cards to extend cornfields almost to the horizon.



Superman's return to city life marked the film's biggest departure from Richard Donner's production, which had shot all *Metropolis* scenes on location in New York. "Our *Metropolis* was not New York City," remarked Bryan Singer. "Our city sat on an island very much like Manhattan, but it was inhabited by more '30s-style architecture, intermixed with modern buildings. It was somewhat like Manhattan, but a bit more subdued. I wanted it to feel very real."

The filmmakers shot *Metropolis* scenes in downtown Sydney, on backlot sets at Fox Studios, and in an aerial New York City shoot conducted late in production. The aerial shoot provided visual effects with a resource for developing establishing shots and flying sequences throughout the film. PLF plotted scenes in previz, then Andy Jones' animation team blocked out *Superman's* flight path over animatics, allowing the production to plan helicopter action with the New York Police Department and aerial personnel.

Aerial cinematographer Al Cerullo, visual effects director of photography Bill Neil and Richard Hoover piloted a Genesis camera in a SpaceCam rig over Manhattan for approximately two weeks, while Imageworks conducted an extensive survey of the city from rooftops using lidar and digital photography, gathering material needed to transform the city into *Metropolis*. "We added features all the way around Manhattan Island," said Richard Hoover. "We modified the iconic buildings — the Empire State Building and the top of the Chrysler Building. We removed Long Island and Staten Island. Anything beyond the tip of Manhattan, including part of New Jersey, we turned into ocean."

Matte painting supervisor Josh Geisler-Amhowitz oversaw 2D digital city extensions. Lead artist Leslie Baker oversaw 3D structures, which included a fictitious bridge seen in an early shot that swooped in over the Hudson River. "The *Metropolis* Bridge was a fully synthetic model," noted Imageworks CG supervisor Bruno Vilela. "Texture artist Daniel Favini textured it with images of the real Brooklyn Bridge and created a cross between a new design and the Queensborough Bridge. We also refurbished the pylons on the actual Brooklyn Bridge, giving them an art deco feel."

The introductory shot arrives at an imposing skyscraper capped by a rotating brass globe advertising the *Daily Planet* — the most heavily featured CG building in the film, and the largest building model ever created at Imageworks. The production art department provided Imageworks with blueprints and a low-resolution 3D model of the 908-foot-tall building in perspective. Imageworks then built a high-resolution building and an eight-block surrounding area, which plugged into New York City plates. "Leslie and I found a location that gave us the best views out the windows for scenes on top of the *Daily Planet*," stated Bruno Vilela. "We then built an entire CG district over that location, just north of the World Trade Center site. We generated a lot of painted textures for the *Daily Planet*. It had a mostly concrete structure, with stone and brass details. For



To effect Superman's flying, using the actor on stage, R.A. Rondell commissioned Climbing Sutra to fabricate flying harnesses worn beneath a muscle suit, while Zero-G Action Rigging Specialists designed and constructed a giant overhead gantry rig erected on the expansive greenscreen stage at Fox Studios. / Neil Corbould's physical effects teams supplied additional rigging and air mortars to simulate wind pummeling the superhero during high-speed flight, while puppeteers — clad in green to blend into the green backing — manipulated his cape via wires.

rooftop scenes, the production shot a 50-foot-wide partial set surrounded by greenscreen. We extended the set with our CG building, and put a CG globe on top.”

Superman’s Fortress of Solitude is introduced early in the film as a group of travelers make their way across an arctic landscape toward a giant structure of interlocking crystals. Production filmed arctic scenes on soundstage sets in Sydney. Rhythm & Hues matte painter Dylan Cole created arctic set extensions and environments using painted and scenic textures projected onto 3D geometry. Modelers then generated a 3D model of the exterior of the Fortress, which dwarfed tiny digital characters representing Lex Luthor and his accomplices.

For scenes inside the Fortress, production built a partial set that reached 35 feet to the studio rafters, filling half a stage. Limited translucency in the load-bearing structures required digital enhancement to create refractive qualities. “We added translucency in set extensions,” said Rhythm & Hues visual effects supervisor Derek Spears. “We put greenscreens where we could to help pull better keys behind actors wherever rotoscoping was going to be tough. We tried not to put greenscreens everywhere due to the amount of spill they created in the set.”

Rhythm & Hues modeled the Fortress interior and combined digital extensions, eventually retaining a small percentage of the studio set, adding deep-background 2D layers, 3D midground layers, and foreground columns with refractive, reflective and subsurface scattering effects. Crystal extensions incorporated Frantic Films’ digital crystal technology adapted to Rhythm & Hues’ in-house ray-tracing renderer, Wren.

Fortress crystals come to life as Luthor activates a central control panel. Kevin Spacey enacted the scene on a raised section of the set built from translucent materials, which Rhythm & Hues digitally rebuilt to grow around the actor. Artists introduced glimmers of Spore into the rendered control panel using projection techniques in distant crystals and deeper volumetric renders close up, with a variable color palette.

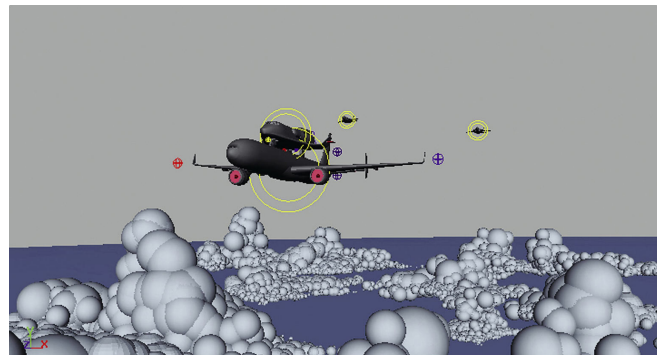
Luthor’s interference activates a giant, glowing hologram of *Superman*’s father embedded in crystal, which refracts around the chamber. Rhythm & Hues generated the effect using footage of the late Marlon Brando unearthed from Warner Brothers’ 1978 film archives. “Brando’s voice and image as Jor-El were so nostalgic and powerful to me,” said Bryan Singer, “I knew I wanted to return to him in the Fortress of Solitude. I went through Brando’s original takes and ADR dubbing sessions — there were some funny bloopers — then we digitally re-created him in three dimensions and occasionally had him deliver lines that were previously vocal tracks.”

The footage consisted of multiple angles of Brando in a white wig, dressed in black, filmed against a black background. Singer used a previz assembly to guide performances on set. Rhythm & Hues then analyzed the audio and video elements. “Brando was extremely expressive in his eyes and eyebrows,” observed Derek Spears. “Wherever we had audio without an appropriate camera angle, we covered up his mouth until we located a facial expression that matched the vocal track. We then built a 3D Brando face, tracked in his facial performance from the nose up, and re-animated the mouth.”

Rhythm & Hues used the Brando footage as basis for hand-modeling Jor-El’s head and generated a 3D facial model. Animation lead Roberto Smith animated lip-sync to Brando’s dialogue, referencing

selected upper portions of the actor's face. Lighting technical director Walt Jones then blended painted and photographic textures. "Texturing was partially projection," stated Rhythm & Hues visual effects co-supervisor Mike O'Neal, "and partially textures generated from various mouth shapes. Every time the mouth moved, the chin wrinkled; so we had to find footage of Brando making a similar vowel shape and extract wrinkles from that. It was a very complicated process to make everything move together seamlessly."

The *Man of Steel* is called into action when disaster strikes Lois Lane and other journalists on the maiden flight of the Virgin Galactic Genesis, a fictional depiction of Virgin's commercial space shuttle launched from the back of a Boeing 777. For on-set use, Neil Corbould's team designed and constructed a 60-by-30-foot steel-frame motion base that supported an interior fuselage set. "The gimbal was 20 feet high so we could take the set through extreme movements and a lot of different angles," explained Corbould. "The aircraft first did a climb; and once it separated from the shuttle, it took a nose dive and started to spin. One of my designers, Dave Brighton, designed a three-axis computer-controlled gimbal that could handle all that motion. We flew it freehand, but recorded each take; so when we got a good take, we could play it back over and over again. It was quite a beast. We had 28 people riding in this set, plus camera crew."



Sony Pictures Imageworks created effects for an action centerpiece in which Superman responds to a disaster aboard a commercial space shuttle launched from the back of a Boeing 777.



Modelers generated the airplane, a modified version of the space shuttle and a pair of fighter escorts for the sequence, which traveled through altitudes ranging from 20,000 feet to the edge of space. Digital artists filled environments with majestic dimensional cloud effects

generated by volumetric rendering techniques developed specifically for the production.

Corbould's team mounted the 777 cockpit on a smaller gimbal rig and supplied motion bases for four other greenscreen aircraft interiors featured in the film. Stunt rigging inside the 777 created zero gravity effects as it reached its parabola. "We attached yachting track sliders down the center of the fuselage," stated R.A. Rondell. "It was a downscaled version of our big double-track wire rig, but inside the aircraft. We were limited by the clearance between the overhead compartments and the tops of the seats, which was about three feet, but we used that to fly Kate Bosworth and her stunt double around as she was bouncing through the ship."

PLF generated flight simulation graphics for the sequence, while Rising Sun Pictures handled greenscreen composites of interior window views.

Imageworks modeled all the exteriors, including the 777, a customized space shuttle, a Lockheed Martin F-35 Joint Strike Fighter escort and four high-altitude environments. Sky domes featured scenic and matte-painted material, depicting scenes between 20,000 and 150,000 feet on the edge of space, with majestic cumulus clouds generated by volumetric rendering, created specifically for the production by lead visual effects artist E.J. Lee. Compositing lead Jason Greenblum then oversaw assembly of clouds, *Superman* and aircraft, interactively blending elements. "Everything in our digital environment was reflected on the planes," explained Bruno Vilela. "Clouds shadowed airplanes, airplanes shadowed clouds, and airplanes reflected clouds. That required a great deal of work coordinating between environment design, character animation and aircraft design."

Lead visual effects artist Eyal Erez devised atmospheric details including aircraft contrails, heat distortions and jet engine exhausts, plus a supersonic phenomenon as *Superman* exceeds Mach One. "Mark Stetson came up with an idea inspired by aircraft carrier footage," noted Richard Hoover. "When jets broke the sound barrier at about 50 feet off the water, they made a condensation dome around their nose cones. It was fascinating to watch, and we re-created that effect with *Superman*. As he broke the sound barrier, he created a white corona of condensation, with a subtle specular rainbow coloration as the sun hit the water vapor."



The space shuttle engines ignite, scorching the sky with smoke and flames. Imageworks generated atmospheric effects to convey the extreme physical forces and high velocity of the sequence. Effects included CG fire, created using fluid simulations in Maya imported into a smoke simulation rendered through RenderMan. Digital artists developed a custom utility to create the impression of flames and embers illuminating columns of smoke, interacting with and reflecting onto the surfaces of the aircraft.

Superman attempts to separate the shuttle from the 777, bracing himself under the spacecraft and momentarily striking a classic hero pose — an entirely animated scene that proved a defining moment for the CG character. “We motion-captured Brandon lifting a metal bar,” Andy Jones related, “then animated on top of that to create a slightly more comic book pose. After he lifted the shuttle, he adjusted his posture, getting ready to guide the shuttle into space — one knee bent, right shoulder forward, left arm back — and that turned out to be a little touch that, all of a sudden, just looked so ‘superhero.’ Mark Stetson called it a ‘Heisman pose,’ after the Heisman football trophy.”

Superman severs the shuttle coupling using his heat vision — a plasma-like particle effect designed to avoid an overtly cartoon-like graphic — then casts the spacecraft into orbit and chases the disintegrating and burning 777 as it plummets. John Monos’ modeling team equipped the 777 with five levels of destruction, revealing new texture maps and models of the internal avionics as the wings broke away and the tail eroded, tied into visceral CG fire effects. “We created synthetic fire with heavy fluid simulations in Maya,” noted Bruno Vilela. “We imported that into a digital smoke simulation and rendered everything through RenderMan. Our main effects artist, Eyal Erez, and supervisor Theo Vandernoot implemented a utility, which allowed us to generate thousands of lights and shoot them through any kind of volume — so the smoke lit up the flames, flames reflected on the plane, and the plane was shadowed by the smoke, debris and embers.”

The 777 hurtles toward a baseball stadium in a city on the New Jersey coast. Production filmed arena scenes in Los Angeles’ Dodger Stadium. Visual effects then gave the location geographical context. “For costume purposes, we had already picked our baseball teams as Baltimore and Miami,” observed Mark Stetson. “We picked Baltimore as the location, then Rich Hoover looked at sites around the Chesapeake Bay and finally worked out an approach coming in over the Atlantic towards Cape May.” Stetson enlisted additional unit director Michael Fink to oversee the SpaceCam helicopter shoot at Dodger Stadium. Fink used previz to guide angles of baseball players and a scattering of approximately 100 extras, and covered wider angles in locked-off tiled plates.

Imageworks used lidar scans of the stadium to construct a 3D model of the arena and digitally projected footage onto the geometry, creating parallax effects between the rows of seats. Artists populated empty stands, using a crowd simulation of 30 different animation routines, and programmed varieties of behavior as onlookers reacted to *Superman*’s lowering the 777 into the stadium. Animators grappled with the inertia of the 200-foot-long aircraft, providing *Superman* with an elegant and heroic fulcrum point. “The nose cone of a 777 was a big unwieldy thing for *Superman*



To film 777 interiors depicting passengers flung about the cabin as the aircraft plummets toward the ground, Neil Corbould’s team designed and constructed a 30-by-60-foot steel-frame motion base that supported an interior fuselage set 20 feet above the soundstage floor. The computer-controlled motion base allowed an operator to simulate aircraft motion, recording takes for playback. Twenty-eight performers rode inside the set with camera crew and stunt team, which rigged the passengers with flying harnesses for zero gravity effects. Rising Sun Pictures generated greenscreen composites for interior window views.

to grab onto,” noted Richard Hoover. “We came up with a solution in that the nose of the plane is flexible — it’s mostly made of fiberglass — so he broke through that skin, grabbed onto the fuselage inside, and that gave him leverage. It was always about selling the audience on *Superman*’s ability to do what he was doing, gradually building up to that suspension of disbelief.”

Back in business as a superhero, *Superman* takes to the skies to watch over his adoptive planet from orbit. “The screenwriters came up with a wonderful notion for this scene where *Superman* rests above the earth,” said Bryan Singer. “It’s after a particularly somber moment in the film; and, at first, *Superman* seems to be meditating, or perhaps suffering in some way, because it’s not a happy time for him. But then we slowly realize he’s distilling all the sounds from below, trying to isolate problems; and then he goes off and starts addressing them.”



Superman returns to business as a crime-fighting superhero, interrupting a bank robbery. The production shot the sequence at street level in Sydney and on a greenscreen rooftop set at the studio. The Orphanage generated rooftop set extensions and visual effects as Superman swoops in to intercept a hail of machine gun fire in a shot that dipped in and out of super-slow-motion. Actors held position as a machine gun barrel rotated at slow speed and the camera navigated the shot. The Orphanage then added bullets erupting from the machine gun and bouncing harmlessly off Superman’s chest.

Known as the ‘Listening Post,’ with *Superman* framed in a high angle over the glowing planet, the scene became a signature shot for the movie. Visual effects staged a greenscreen shoot with Brandon Routh in a motion control camera move that rotated around the performer and ended on a closeup. However, mechanical problems on the day of shooting resulted in Imageworks using only a small portion of the footage. “We got the closeup of Brandon’s face at the end,” said Richard Hoover. “Everything before that we developed digitally, with subtle body language in his hands, eyes and face. It was a very delicate type of animation, with a poetic flow to the cape.”

Zero-gravity cape animation required that believable physics be blended with the poetry of the scene. “At first we didn’t know whether we wanted any movement in the cape,” remarked Andy Jones. “There is obviously no wind in space; but Bryan wanted a slight subtle drift, which added life to the shot. We simulated the cape motion in almost real time, and then we slowed it down to about four frames per second, until it was really smooth.” *Superman’s* facial animation drew heavily on the library of Brandon Routh’s motion capture facial shapes, which animator Virginie D’Annoville then nuanced with subtle detail.

Image-based facial textures and lighting gave the character its final breath of life. “The hair shadowing the head, and the head shadowing the costume all used IBR techniques baked into the photography,” said John Monos. “The lighter then determined colors and ratios and positions of lights to capture the feeling of the shot. We had a warm sun going down on the horizon, which we played as an edgier key light; and then we used low ambient tones to create a softer feeling of intimacy as the camera approached. The camera was moving 360 degrees around him, so we moved the lights around him, as well, lighting him to camera as a cameraman might with a real actor on set. The shot became a benchmark for how close we could get to our synthetic character.”

Returning to earth as a crime-fighter, *Superman* foils a rooftop bank robbery. Production shot the sequence on a nighttime street location north of Sydney and a rooftop soundstage set at Fox. *The Orphanage* handled visual effects, employing panoramic background textures photographed from the roof of the location by visual effects supervisor Jonathan Rothbart. *The Orphanage* tiled images



Superman powers through downtown Metropolis, skimming city streets at near-ballistic velocity. For flying scene backgrounds, the production shot aerial footage of New York City and lower-altitude plates around Sydney, referencing detailed previsualization created by Pixel Liberation Front. The skyscraper canyon passage was filmed using a wire-flown camera piloted above a Sydney city street. Imageworks then composited a digital double Superman, created from extensive surveys and a high dynamic range image-based rendering of Brandon Routh.

into a 270-degree digital cyclorama tracked to greenscreen rooftop sets, added whirling rotor blades to the thieves' getaway helicopter, and animated Imageworks' digital *Superman* darting close by frame, outracing machine gun fire.

Superman blocks the hail of bullets, seen in a prowling camera move that dips in and out of super-slow-motion. "We used an old-school trick to shoot that," stated Jonathan Rothbart. "They set up the machine gun to slowly rotate, everyone held their positions, and we shot a Steadicam move around the actors with the Genesis camera. Right at the end, it jumped back into real time." *The Orphanage* CG supervisor Adam Martinez added CG bullets with super-slow-motion ballistic effects rendered in Houdini. "Machine gun tracer fire normally appears like a red or green streak of light through frame. We had no motion blur in the shot, so we analyzed the process that created the streaks of light. We rendered particulate matter illuminating volumetric smoke following the bullet, with sulfur deposits and shavings from rifling in the gun. Muzzle flashes that normally appeared as pulsating light in super-slow-motion were gaseous explosions of smoke and flame spewing out of the gun, surrounding the bullets and then receding." Orphanage artists matchmoved Brandon Routh's chest position and then animated digital impact dimples as bullets pinged off *Superman*'s impenetrable body.

Superman displays another classic superpower of 'x-ray' vision in a number of scenes, gazing through solid objects at will. "*Superman* sees through objects selectively," explained Bryan Singer. "Unlike an x-ray, which picks up rigid matter or bone matter and looks monochromatic, *Superman*'s eyes optically slice through objects, like an MRI or CAT scan, to get to where he wants to see."

An early x-ray sequence occurs when *Superman*, as Clark Kent, spies on Lois Lane through the walls of her home, revealing her family life inside. Using motion control, production shot a house exterior at a Sydney location that allowed a view from the street into the kitchen. Rising Sun Pictures used surveys of the location to build a digital model of the house and reconfigured other house interiors to story needs. Previz artists then choreographed camera moves to simulate Kent's roving point of view, gliding from room to room and dissolving through furniture and internal structures. The animatics guided construction of breakaway sets on soundstages at Fox. Bill Neil then shot multiple motion control passes of house interiors, removing walls and props in repeated takes. Rising Sun gathered high dynamic range images of sets to rebuild objects using image-based camera projection, mapping textures to geometry as the camera pushed through internal structures of furniture and walls.

'X-ray' penetrations were based on concepts developed by Rising Sun art director David Scott, utilizing magnetic resonance imaging technology as reference. "If you study atomic structure," observed Tim Crosbie, "we are all more than 95-percent space, held together by strong and weak atomic forces that stop photons from bouncing straight through us. This is how I imagined *Superman* might perceive that structure, making things transparent or opaque as he focused his attention." Rising Sun research and development technical director Dan Bethell developed an x-ray cut-through tool using combinations of Maya, Shake and volumetric displacements. "Traditional 3D modeling software just builds surfaces, so objects are really only shells. Using 3D volumetric shaders with advanced camera-clipping planes, our cut-through tool enabled us to reveal internal volumes. As we cut through volumes, the clipping planes took on the three-dimensionality of the

textures they were cutting — for example: when we cut through wood, areas that were denser and more difficult to cut through appeared raised, offset in 3D space. It was a very organic effect.”

Back in the public eye, *Superman* meets Lois in a rooftop rendezvous on top of the Daily Planet building and takes her for an aerial tour of *Metropolis*, rekindling old feelings. Routh and Bosworth performed the meeting on a greenscreen rooftop set, with Bosworth taking position by stepping onto Routh’s feet. Imageworks animated wide angles of the couple’s ascent. “*Superman* holds Lois in a comfortable position, as if she’s used to it,” noted Andy Jones. “Bryan wanted it to seem like she had done this many times. As they fly together, it becomes more romantic, like a swirling dance.” Routh and Bosworth enacted greenscreen elements of the flight in dual flying rigs, wearing hip-mounted harnesses linked together, while lighting gaffer Shaun Conway simulated ambient city glow.

Imageworks compositing artist Donny Rausch integrated live and digital characters into aerial plates shot with the Genesis camera 10,000 feet over Manhattan. “The detail in the Genesis images of the city was remarkable,” said Mark Stetson. “It was an absolutely crystal-clear spread of the city. Rich Hoover’s team tiled all that together, and changed the shoreline and bridges. Guy Dyas and I spent some time thinking about replacing the Statue of Liberty with a fictitious monument, but the structure is so iconic, anything we came up with to replace it seemed too much like 1930s Russian propaganda; and so we had it removed.”

Other establishing shots of *Metropolis* and street-level scenes featured matte paintings and environment extensions generated at *The Orphanage*, which used New York City scenic material, plus plate photography and lidar scans of Sydney street locations. The extensions were featured in an action sequence shot in Sydney involving a runaway car chase in which Lex Luthor’s sidekick, Kitty Kowalski (Parker Posey), attracts *Superman*’s attention by steering an out-of-control Mustang across streets and sidewalks, until *Superman* catches the vehicle.

R.A. Rondell and second unit director Dan Bradley staged the scene with a stunt driver weaving through traffic, down stairs and across an outdoor orchestra pit. *The Orphanage* shot background plates, replicated Sydney architecture for greenscreen vehicle interiors and generated a CG car for *Superman*’s interception. The stunt department then collaborated with physical effects to lower a practical car to street level using a 100-ton crane.

“Bryan Singer asked us to re-create the cover of the first issue of *Action Comics*,” remarked Neil Corbould, “which had *Superman* holding a car in a particular pose; but we didn’t have a lot of time on the streets to do it. We tested everything at Fox, then went out at four o’clock in the morning and



Superman takes Lois Lane (Kate Bosworth) on an aerial tour of *Metropolis*, rekindling latent feelings from the pair’s romantic past. Imageworks animated wide angles of the couple’s ascent from the rooftop of the Daily Planet. The actors performed greenscreen elements of the flight in flying rigs, wearing hip-mounted harnesses linked together. Imageworks then merged live and digital characters into aerial footage shot high over Manhattan, tiling motion picture plates and digitally manipulating them to eliminate recognizable New York City landmarks.

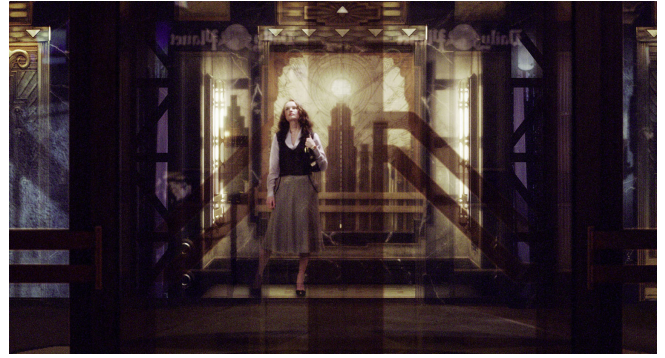
rigged it over the road, attaching cables to a crane with a hydraulic rig on the end of a hook so we could puppeteer the car with Brandon underneath.”

Luthor’s scheme to hijack *Superman*’s Kryptonian technology involves exploiting a rich benefactor who resides at the Vanderworth Estate, located across the river from downtown *Metropolis*. *The Orphanage* enhanced plates photographed at a real mansion in Sydney. “We re-created the shoreline and *Metropolis* on the other side of the river,” related Jonathan Rothbart. “We rendered the water in mental ray, then added an island, boats in the river and Lex’s yacht, the *Gertrude*.”

Rhythm & Hues supplied *The Orphanage* with a digital model of the *Gertrude* derived from a miniature constructed by Photon VFX from art department concepts. The fanciful craft was inspired by the palatial yacht, the *Octopus*, belonging to real-world billionaire industrialist Paul Allen. Guy Dyas designed several sets to represent the futuristic, gleaming vessel, including a glass-floored salon with a view into the ocean, a front deck with bar, hot tub and gym, a bridge and interior cabins. Photon built a 1/8-scale yacht that measured close to 35 feet in length, and a 1/3-scale partial miniature for closeup work. Model-makers sculpted the *Gertrude* in foam, produced a fiberglass-skinned hull and detailed interiors with furniture and lighting. Photon designed the 1/8-scale miniature for ‘dry-for-wet’ photography and shot 1/3-scale sections in a water tank at Movieworld Studios in Queensland, using high-speed photography. “We were not able to convince the Genesis camera to shoot high speed,” noted Dale Duguid. “So we were forced to use 35mm film for that work. That coverage included some cable-flown camera rigs to swing the camera over the miniature in the water tank.”

Revisions to the story resulted in the 1/8-scale miniature remaining unused in favor of a modified digital design. Rhythm & Hues shot high dynamic range image surveys of the miniatures for use in building digital counterparts of the yacht, built from an art department CG model, and integrated the vessel into entirely digital ocean environments. “We took the original digital plans and textures of the yacht,” related Mike O’Neal, “and then refined them with Mark Stetson to make the yacht a little sportier.”

To place the vessel into storm-tossed seas, Rhythm & Hues developed a water simulation pipeline — one of four employed in the film — using Houdini Vmantra shader software written by Rhythm & Hues’ resident water simulation guru, Jerry Tessendorf. The water pipeline consisted of a number of in-house applications, including Ahab fluid simulations, iWave water surface displacement tools and Felt volumetric tools for rendering splashes. “We created layers of wave displacement driven by the simulations,” said O’Neal. “We used realistic light refractions for depth and occlusion, with 30 to



With his ‘x-ray’ vision, *Superman* spies on Lois inside an elevator in the *Daily Planet* building. The production designed x-ray scenes to avoid a literal interpretation of x-ray imagery, instead depicting *Superman*’s point of view optically slicing through solid objects, much like an MRI or CAT scan. Mark Stetson collaborated with the art department and with Rising Sun Pictures to stage x-ray scenes using cutaway sets, filmed in multiple motion control passes. Rising Sun composited layers with digital re-creations of set pieces to impart the illusion of *Superman*’s vision penetrating objects.

40 layers of light qualities. We had layers of foam and particles coming off the peaks of the waves, and a lot of 2D element enhancement so compositors could mix in foam elements.”

Artists created effects of swirling whitewater and ocean mist digitally, using volumetric simulations. Derek Spears and Bill Neil also shot foam elements in a helicopter shoot off the Australian coast and captured digital video of stormy seas crashing onto rocks off the California coast. The footage served as a crucial ingredient in a sequence in which Lex Luthor activates his master plan, establishing an impregnable fortress 40 miles off the coast of Metropolis by tossing a shard of kryptonite into the sea, causing giant crystals to sprout up and form a crystalline island, known as ‘New Krypton.’

Frantic Films initiated crystal growth using digital crystal technology derived from nature. “We studied time-lapse photography of salt crystals growing under electron-microscopy,” commented Chris Bond. “We wanted to avoid simple extrusions or transformations, and we were fighting the herky-jerky feel of time-lapse photography. We wanted crystal growth to be quite smooth, but to have some life to it.” Borislav Petrov devised crystal growth in 3ds Max, while Mark Wiebe developed virtual Boolean technology and a range of crystal shaders. Frantic utilized its in-house fluid simulation system, Flood, to introduce particles into fluid simulations, animating churning silt and underwater particles, and rendered crystals to take on the appearance of the turgid environment, absorbing ocean colorations.

Metropolis is shaken by a series of seismic events caused by the tectonic trauma of New Krypton’s growth and excavation. *Superman* races to avert disasters around the city in an action sequence that evolved late in the production to avoid duplicating other superhero films. “I saw the trailer for *X-Men 3*,” remarked Bryan Singer, “and as soon as I saw their bridge sequence I knew our sequence where we had a bridge in jeopardy would have to go. I also wanted to do a subway train sequence, until I saw *Spider-Man 2*. There’s a strange obsession that all directors seem to have with bridges and trains. It might be Hitchcock’s fault, or David Lean’s; but we just can’t get enough of them! I had to force myself not to do that.”



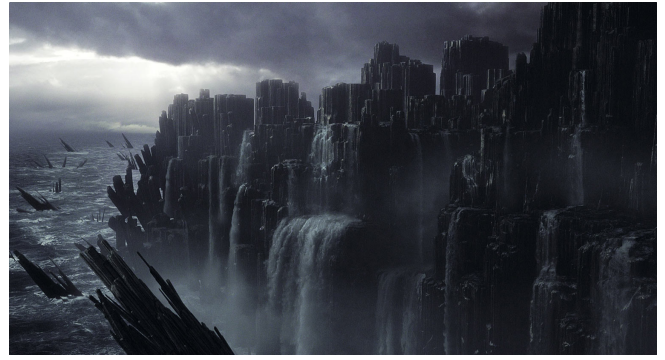
Lex Luthor’s scheme to hijack Superman’s Krypton technology involves exploiting a rich woman who resides at the Vanderworth Estate, located across the river from downtown Metropolis. The production shot the Vanderworth mansion at a practical location in Sydney. Artists at The Orphanage enhanced the environment with a digital shoreline and distant views of the Metropolis skyline on the far side of the river, created using New York City scenic material, combined with a CG river, digital water traffic and Luthor’s yacht rendered from Rhythm & Hues’ model of the Gertrude.

For one disaster scene, physical effects generated a tremor through the Daily Planet newsroom. “The newsroom set was huge and solid,” said Neil Corbould, “and there was lots of glass in the set — so we couldn’t shake the walls too much. Luckily, they had hung the glass on hinges, so we could use wires and little rams. We also rigged all the pillars in the center of the room and set up a computer-controlled system of hydraulic rams underneath the tables and chairs. That allowed us to make everything jump three or four inches into the air, creating a shock wave through the room.”

Imageworks and *The Orphanage* used New York plates as a foundation for shots of Metropolis shaken by earth tremors, including one in which the Daily Planet globe topples from its perch. Imageworks animated the globe crashing to the street using rigid dynamics, intermingling practical effects of debris dropped from cranes in Sydney locations. Other enhancements were digital and matte-painted storm clouds, erupting manhole covers, breaking windows and flying dust generated in Maya.

Capping off the sequence, a gas main beneath the city ruptures and ignites, sending a giant fireball racing through its gas delivery infrastructure, threatening to detonate the main refinery. Production shot footage in Sydney’s electrical power-line tunnel. Imageworks enhanced the environment by adding CG gas pipes. Tunnel interiors featured miniature pyrotechnic elements created by New Deal Studios and pyrotechnician Richard Helmer. “New Deal built a 1/3-scale tunnel,” remarked Richard Hoover. “We filmed it at high speed and blew practical fire down it. We used footage of Brandon Routh in a greenscreen flying rig, lit with simulated firelight, and integrated that with our CG character out-racing the fire.” *Superman* attempts to extinguish the flames using super breath, created through a combination of practical liquid nitrogen and particle system elements.

Back on Luthor’s yacht, giant mineral extrusions thrust toward the ocean surface, seen through the Gertrude’s glass-bottom hull. Bill Neil filmed the salon set with a black backing beneath the boat’s transparent floor. Rhythm & Hues keyed mattes and reflections from the set and added a digital underwater environment with volumetric lights shining into the murk. Modelers adapted Frantic’s crystal technology and conducted further research with the American Society of Crystal Growth to create crystal spires. “The crystals were not purely kryptonite,” stated Mike O’Neal. “They were more like dark-greenish basalt logs. We modeled long shapes that became more complicated closer to their tips. They had very specific actions — thrusting and piling up — so we hand-animated a lot of it.”



Cast into the ocean, Luthor’s stolen kryptonite triggers the growth of alien crystals that thrust up from the seabed to form a sinister landmass, dubbed New Krypton. Framestore CFC created final stages of the crystal growth, following scenes of underwater crystal formation done at Frantic Films and subsequent eruptions by Rhythm & Hues. Framestore CFC water simulations, capped with volumetric and physical splash elements, produced crystal and ocean interactions, layered with atmospheric effects beneath digitally rendered stormy skies.

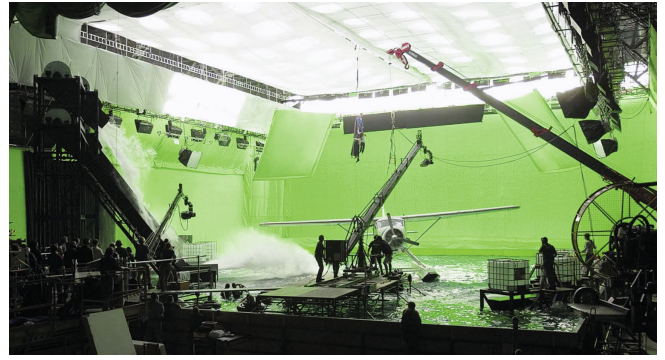
Crystals release air pockets, which effects technical director Nikki Makar achieved using particle simulations of bubbles that reflected, refracted and wiggled as they rose toward the surface. Crystals pierce the Gertrude's hull, smashing through the glass-bottom floor and shattering the salon roof, animated with explosive volumetric water simulations, dynamic interactions of cracking crystal fragments and 2D water elements.

Neil Corbould's team staged a physical effect with performers in a motion base set of the yacht's pantry rigged to sink inside the 10-foot-deep water tank in Fox Studios' Stage 2. "We needed at least 14 feet of water," said Corbould. "We built up the sides of the pit and constructed the gimbal above that. The gimbal slid across the tank, horizontally, and lowered the set into the water like a big forklift. It sat on a seesaw rig, which allowed us to tilt the set, creating different angles of water. We then piped the set with water and air jets, and employed six-inch submersible pumps to churn the water."

Rhythm & Hues generated wide shots of the yacht heaving from the water, impaled on a crystal column, using the digital Gertrude, churning greenwater and crashing whitewater simulations combined with volumetric elements to emphasize scale. "Every ocean shot was completely digital," asserted Derek Spears. "We had hard-edged splashes pushing out, with very misty, cloudy splashes emerging underneath, shadowing one another. It was not a true physical simulation; but our Felt and volume tools allowed us to render different styles of elements and combine elements to make it interesting."

The Gertrude fractures amidships, revealing internal deck detail, animated at Rhythm & Hues using keyframe animation and dynamic fracturing effects. The two halves sink, threatening to drown the occupants, who are seen in a high-angle overhead shot, the camera pulling back as water pours in. Rhythm & Hues tracked performers into a miniature plate of the severed yacht, then nested elements into a digital water simulation with the CG bow of the ship, and extended the stormy ocean on all sides with additional CG flotsam and debris. *Superman* hauls the Gertrude's aft section from the water in an all- digital shot framed through crystal columns beneath a brooding sky, with the *Man of Steel* a tiny speck on top of the ship, animated by Rhythm & Hues using the *Superman* digital stunt double.

Crystals continue to grow from the ocean, forming a miles-wide landmass of crystalline peaks and valleys. Framestore CFC generated New Krypton in set extensions and as fully synthetic environments, deriving New Krypton's rock look from physical set pieces, and developing digital crystal technology for shots featuring translucent kryptonite. "Ray-tracing can take forever," observed Framestore CFC visual effects supervisor Jon Thum. "In some shots we had hundreds of



Lois Lane and her companion, Richard White (James Marsden), land a seaplane in a flooded canyon, coming to Superman's aid as New Krypton continues to grow around them. The production mounted the plane on a gimbal rig furnished by Neil Corbould's physical effects team, and created practical water interaction using dump tanks poised above the set. Framestore CFC generated digital set extensions and fully synthetic environments, incorporating a CG plane soaring through the canyon and over a waterfall, practical water elements combined with digital water simulations, and animated growing crystals.

kryptonite crystals breaking through rock on a very large scale, so we found shortcuts to render those, using shading and 2D tricks to make crystals look refractive.” Framestore CFC generated rock crystal extensions in the live-action foreground, huge matte-painted vistas with CG seas in background areas, and generated a CG seaplane, helicopter and *Superman* stunt double. CG supervisor Justin Martin created crystal and ocean interactions using layers of digital water simulations capped with volumetric and physical splash elements.

For wide shots of the crystal island, Framestore CFC developed a modular modeling approach. “There was no way one big model would have worked for all of our shots,” said Thum. “We had everything from closeups to shots that were miles away. So we built high-rez and low-rez pieces of terrain that stuck together, like building blocks. We had coastlines, canyons and crystal peaks, with different scales for each. We built pieces that we could animate growing, and others in their final form. We then built each shot by moving pieces around until we found the best composition.” Island panoramas, overseen by matte painting supervisor Martin Macrae, employed 2D elements projected onto 3D geometry, with animated camera moves.

Superman confronts Lex Luthor in New Krypton and is overcome, stabbed with kryptonite. Kevin Spacey performed the scene wielding a resin prop representing the kryptonite shard. Framestore CFC enhanced the prop with visual effects animation. Luthor then exacts his revenge on his old nemesis. “Lex is a pretty dark character in this movie,” observed Mark Stetson. “His thugs kick the heck out of *Superman*, which we did with stunt work and some digital replacements; and, at the end of the sequence, *Superman* takes a long plunge.”

Lois and Richard White land a seaplane in a flooded crystal canyon and rescue the fallen hero as crystals

continue to grow around them. Production shot closeups with performers in a water tank and on board a gimbal-mounted seaplane. Framestore CFC created set extensions for wide shots of a CG seaplane soaring through the crystal canyon and plunging over a waterfall. “We used live-action and waterfall elements where we could,” said Thum. “For shots that needed more dramatic 3D moves, we developed a CG waterfall that interacted with growing crystals.”

After recovering from his ordeal, *Superman* returns to New Krypton, plunges beneath the ocean and applies all of his superhero might to lift the island from the seabed. Routh performed underwater scenes in the water tank at Fox, assisted by stunt rigging. “We dragged Brandon through the water on a horizontal plane,” said R.A. Rondell. “We were pulling him as opposed to ‘flying’ him because the water maintained his buoyancy. His cape tended to float because it was mostly made of rubber, so we rigged it with fishing weights and manipulated it with monofilament.”

Framestore CFC animated the digital double for shots of *Superman* powering through water, using his heat vision to boil water and cut through rock. Compositing supervisor Gavin Toomey created an underwater look using Framestore CFC’s existing pipeline. “We had everything set up for the underwater work we had done for the fourth *Harry Potter* film,” stated Jon Thum. “We plugged *Superman* into that, and it pretty much worked right away.”

Framestore CFC also created the underside of the island, using photographic images of mountaintops, inverted, and geological reference of bedrock impregnated with crystals. Artists

projected textures onto geometry, and then animated rocks crumbling and falling into the sea, with 2D and 3D veils of seawater pouring off the island, sending up clouds of mist.

Framestore CFC contributed shots of *Superman's* ejecting New Krypton outside of earth's atmosphere. That action segues into shots handled by *The Orphanage* as the depleted *Man of Steel* falls back to earth. Routh and stuntman Mike Massa performed portions of the fall in greenscreen wire rigs. *The Orphanage* generated digital clouds, high angles of Metropolis, SyFlex cape simulations on the digital stunt double, and added digital legs to the live performer to better choreograph leg motion. For lower-altitude views of *Superman* crash-landing in a Metropolis municipal park, *The Orphanage* used a miniature mockup of the environment to assist digital matte paintings. "We built and photographed a small version of the park with a crater," said Jonathan Rothbart. "That helped us get some nice lighting for a top down view of the impact site and for a side shot inside the crater looking out as bystanders come to take a look over the edge."

After resolving his relationship with Lois, *Superman* takes flight, closing out the film with an aerial sequence designed to evoke the *Man of Steel's* heroism. "Even though it's a new story," commented Mark Stetson, "this movie, at its heart, was all about nostalgia; and so Bryan wanted to end the movie the same way that *Superman: The Movie* ended, with a montage of shots of *Superman* flying off into space." Previz artists rotoscoped footage of Christopher Reeve's final flight to guide Brandon Routh's greenscreen performance in the scene. For further inspiration, Stetson researched a TV station sign-off that contained footage of a soaring F-104 Starfighter accompanied by stirring music and a reading of High Flight, a poem written by John Gillespie Magee, Jr., a young American pilot killed in World War II. "I remembered this TV station sign-off from when I was a little kid, and we tracked down a copy. On a lot of levels, it summed up what our movie was about."

Singer and his screenwriters responded to the footage and expanded *Superman's* final flight into a wordless musical coda that captured the grace and dignity of the poem. The sequence ultimately incorporated two greenscreen shots of Routh and a series of epic shots of the digital character flying through synthetic volumetric clouds. "We tried to follow the flow of Brandon's motion as much as possible," said Andy Jones, "and at the same time we tried to capture the feeling of Christopher Reeve's performance, interpreted through Brandon. We matched that digitally and got a lot closer to the character than we ever thought we could, which was a testament to the work that John Monos' team did in catching the lifelike photographic quality of the face."

The attention to detail was fueled by affection for the enduring persona of the film's 68-year-old title character. "Making *Superman* work for a new audience was really fun," concluded Mark Stetson. "In some ways, we ignored the context of *Superman* in the 21st century and focused on his classical image. There certainly were modern elements to the story, but the conflicts were familiar; and *Superman's* conflicts with himself as an alien in America were, if anything, amplified in this movie. *Superman* is almost invulnerable, yet he doesn't feel like he's part of our world. Those were themes that worked whether the guy was in blue tights running around in the 21st century, or not."

Superman Returns photographs copyright © 2006 by Warner Brothers. All rights reserved. Production still photography by David James. Special thanks to Gina Soliz, Steve Rogers, Rachel Falikoff, Carlye Archibeque, Diana Stulic, Shawn Burns, Maricel Pagulayan, Scot Byrd, Andrea Snow, Amy Garsia, Martin Parker, Steph Bruning, Rama Dunayevich, Kelvin Liu and Marc Cohen.

ARTICLE BY JODY DUNCAN

Of all the American pop-culture phenomena that ‘scream’ the 1970s, few sound more loudly than the disaster film. Airport initiated the trend in 1970, and was soon followed by people-in-peril flicks such as *The Towering Inferno*, *Earthquake*, *The Hindenburg*, *The Swarm*, *Avalanche* and *The Poseidon Adventure*. Though disparate in terms of boxoffice performance and critical appeal, all of these movies shared immutable characteristics of the disaster film formula: storylines in which catastrophic events bring together groups of strangers and lead to common-man (and woman) heroics, casts peppered with name actors beyond the peaks of their careers, explosive special effects, and generous helpings of cinematic cheese.

The desire to remake some of those 30-year-old films in the present day is fueled not only by a nostalgic affection for them, but also by a curiosity as to how they might be elevated through state-of-the-art digital effects. Theoretically, at least, computer generated aircraft, burning skyscrapers, earthquakes, bee swarms, avalanches, ships and oceans could produce many more thrills and more realistic action than what had been possible with practical models and other in-camera effects of old.

Poseidon, director Wolfgang Petersen’s update of *The Poseidon Adventure*, tested that premise — to its limits. Though the narrative would be re-crafted for modern-day audiences and all of the characters would be different — gone are the charismatic pastor and the overweight ex-swimming champion — the essential storyline would remain the same: after an ocean liner carrying thousands of passengers on a Christmas season cruise is capsized by a huge rogue wave, a small band of survivors makes its way through an inverted labyrinth of damaged, flooded and fiery interiors, finally exiting through the upturned hull of the ship.

Petersen, visual effects supervisor Boyd Shermis and visual effects producer Rhonda Gunner looked to the latest in digital technology to create an ocean-bound adventure that would top previous pictures featuring similar action sequences. “There were two fundamental goals from the beginning,” revealed Shermis, “to out-*Titanic Titanic* in terms of the look and behavior of the ship, and to out-*Perfect-Storm The Perfect Storm* in terms of the ocean water and wave. Wolfgang wanted this to be the most spectacular shipwreck of all time. To create that, we had to raise the bar on the wonderful work that had been done on *Titanic* and *The Perfect Storm*.”

Though the final cut would feature just over 500 visual effects shots — a modest number for an epic action/adventure movie — those shots were uncommonly lengthy and complex, requiring the combined efforts of several effects houses. At the beginning of their 18 months on the show, Shermis and Gunner assigned the main body of work to Industrial Light & Magic, The Moving Picture Company, CIS Hollywood, Giant Killer Robots and Hydraulx, and engaged Lola Effects to do substantial plate cleanup.

While the original *Poseidon Adventure* had been largely an in-camera affair, *Poseidon* relied heavily on the contributions of these effects vendors. ILM’s slate of 96 shots provided the film with its title character, the *Poseidon*, and established its presence on the open sea. “The production didn’t build

any of the ship exterior for real,” stated ILM visual effects producer Jeff Olson, “except about 20 feet of deck with a door and a railing. Not one single thing you see outside the boat was photographed. All wakes, all horizons, all oceans, all exteriors of the ship were created in our computers.”

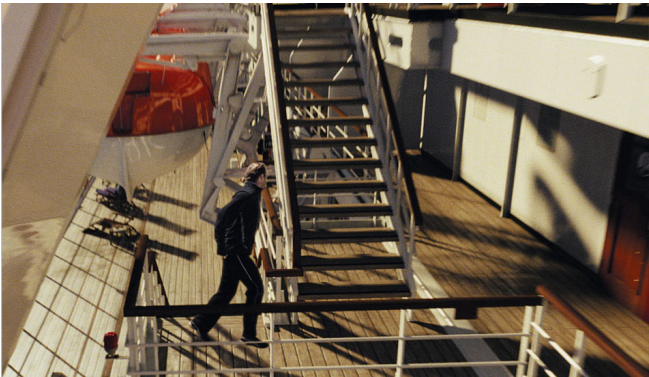
In 1999, ILM had delivered similar small miracles for another Wolfgang Petersen production — *The Perfect Storm* — creating computer generated seas that were, at that time, the most realistic and compelling water shots ever produced via computer graphics technology. As groundbreaking and difficult as that assignment had been, however, *Poseidon* would demand much, much more. “We had to take CG water to a whole new level with this show,” explained Boyd Shermis. “In *Perfect Storm*, the boat just bobbed on top of a geometric water surface. In *Poseidon*, we had to wrap a huge CG wave around our ship, and then roll that ship around in that 3D volume of water — all at very high resolution and on a massive scale. That was a much greater challenge. The only company we could conceive of having the technical expertise to develop the 3D water — and the horsepower to render it — was ILM.”

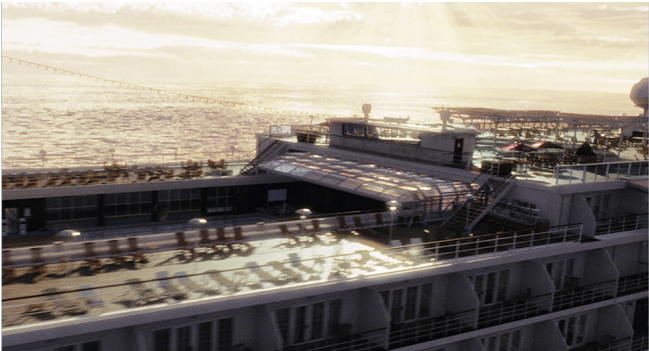
Enormous rendering power would also be needed to create the ocean liner *Poseidon*. Production would build a number of full and partial ship interior sets — some in both right-side-up and upside-down configurations, the latter for shots after the boat has rolled — but exterior views of the ship did not lend themselves to in-camera solutions. At more than 1,100 feet long, the fictional *Poseidon* was bigger than any cruise ship on the sea. Shooting a smaller real-world stand-in was also out of the question, as no cruise line was eager to have its boat used for a movie about an ocean-bound disaster. “We’d say to the cruise lines: ‘We’d like to hire your ship for our disaster movie about a ship that sinks. How about it?’” Shermis recalled. “They weren’t very excited about that concept, obviously. One company briefly entertained the idea, and they allowed us to scout a real cruise ship. We had a day to go in and photograph every corner of this ship, which gave us a lot of great reference material. But, ultimately, none of the cruise companies was interested in letting one of their ships represent the *Poseidon* in this movie.”

Miniatures — which had been used sparingly and crudely on *The Poseidon Adventure* — were also not an option, given the boat’s size. Even something as small as a 1/10-scale miniature ship — an insufficient size to hold scale in water — would have translated to an unwieldy 110-foot-long model. “To hold scale in water,” noted Shermis, “we’d have had to build something no smaller than 1/5 scale, which would have measured almost 220 feet long! That was totally impractical. The one thing that was perfectly obvious as we started developing this movie was that we would not be able to do anything with the ship practically. We weren’t going to be able to use miniatures in a tank, and we weren’t going to be able to take a ship out on the ocean and get shots that way.”



With a realistic effects role in a display from visual effects supervisor, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000





With no practical solution, Petersen and Shermis challenged ILM's dedicated crew, led by visual effects supervisor Kim Libreri, to create a synthetic Poseidon that looked absolutely photoreal, even in close views. The result, after more than a year of development, was the most detailed, largest CG model ever built at ILM. "We knew going in that it would have to be bigger than any of the models we'd done before," said ILM associate visual effects supervisor Mohen Leo. "Prior to this, the Federation Cruiser from *Star Wars* Episode III was the heaviest model we had ever built. But at the beginning of this show, we looked at that model, and said, 'That's not going to be enough.' The Federation Cruiser was very abstract; but a cruise ship is a real thing involving an incredible level of detail. There are signs, towels, doors and door handles, windows, lighting fixtures, tables, deck chairs — a cruise ship is basically a small city. Every part of this model would have to have texture and dirt and bumps to sell that it was real."



ILM generated two lighting schemes for the Poseidon, one for daytime views, and another for night, in which most of the film's action is set. Nighttime lighting was keyed to the ship's modeled light fixtures, with 1,200 CG lights illuminating the ocean liner in full exterior shots. Working in mental ray, ILM used ray-tracing to render the ship and create photorealistic lighting, then added ambient glows in compositing.

Under the supervision of layout lead Vince Toscano, ILM modelers referenced blueprints from the production art department and materials gathered from other sources to guide them in the ship build. "We had a lot of reference from the Queen Mary," said ILM digital production supervisor Pat Conran. "And since we're at the Presidio now, we had wonderful views of cruise ships in the bay. Whenever a cruise ship would pass underneath the Golden Gate Bridge, we'd yell, 'Cruise ship!' and everyone would come running to a window to look at it. Mohen Leo used to go out on Sundays and snap pictures of ships in dry dock, as well. We were also lucky enough to have a crewmember who went on a Christmas cruise, and she took photos. We had brochures from the cruise lines, of course; and it's amazing what you can find on the Internet. We wound up with a lot of reference for different parts of a cruise ship."

The final computer model would represent a ship that measured 1,106 feet long from bow to stern and 224 feet tall from the base of the hull, and featured 382 luxury cabins. Working in Maya, three full-time modelers built up a 'Lego' kit of 6,500 separate ship set pieces over the course of eight months. "We broke it down into the number of doors we needed, for example," explained Vince Toscano. "How many double doors made out of teak? How many metal doors? We modeled all of those set pieces — windows, vents, portholes, doors — then rearranged and attached them to different walls and things to create custom, unique sets. By combining and building up all of these different Lego set pieces, we wound up with a very dense model."

In total, ILM modelers produced 181,579 individually renderable pieces to build the basic structure of the ship and dress it with items such as coffee cups, chairs, newspapers, juice glasses, ash trays, towels, and the like. The pool area of the ship alone featured 20 newspapers and magazines spread around, as well as 73 tables, 37 bar glasses and two fully stocked bars. Toscano's team was also responsible for moving elements of the cruise ship — such as spinning radar antenna, fluttering

magazines and towels, rippling flags and swaying strings of lights — animated through an engine in ILM's proprietary Zeno software.

After all of the structural and dressing components of the model had been constructed, the crew assembled specific sets on a shot by shot basis. "We'd get the gross layout of a shot from the camera guys," said Toscano, "and then dress out that shot for the camera. We could look at it, and say, 'Wouldn't it be nice if there was a painting over here and some lamps over there?'" In building up each specific scene, the crew worked with lightweight proxy pieces of geometry representing the individual set pieces. "The proxy models just gave us a rough contour of the shapes. A chair would look like a chair, which enabled us to position it properly; but it was a very simplified version. Then, when we hit 'render,' that simple chair shape became extremely detailed and complex."

Lighting was key to making the final rendered ship look photoreal. CG supervisor Philippe Rebours devised a lighting technique dubbed 'Cine-Radiosity,' which added a much-needed level of flexibility to standard global illumination. "What made the rendering and lighting on the ship so challenging was that it was a huge asset with many, many components," noted Pat Conran. "And then, after the roll, everything was wet, which meant everything was reflecting. So we had to use global illumination. But one of the problems with global illumination is that it gives you what it gives you when you hit 'render.' It is very difficult to control or to art-direct. If you want more light here or there, it doesn't really allow for that. Philippe implemented a technique that allowed for that extra control. It was very easy to add extra light in a corner or extra bounce light on a surface. So it was like global illumination, but more cinematic in that it gave the artist this extra level of control to art-direct it."

Due to the global illumination requirements, ILM used mental ray for rendering, pushing the limits of what the software could do to meet the demands of the show. "We really had to stretch what mental ray could do," recalled Pat Conran. "We wound up working with the engineers from mental images quite a bit to get it to the point that it would give us what we needed."

The ship — seen in daylight, initially, and then at night for the remainder of the film — required lighting schemes that would work in both environments. Nighttime lighting was keyed to actual modeled light fixtures. "We modeled 840 unique lighting fixtures on the exterior of the ship," explained Vince Toscano. "So, when you saw the ship at night, all lit up, all of those fixtures were illuminated. They weren't just CG lights hanging out in space. Because we were doing full ray tracing, we were able to have a little light source sitting in a glass housing, illuminating through the glass and



Though production designer William Sandell and his crew created a number of full-scale interior sets – many of which were rotated on gimbals by special effects supervisor John Frazier during scenes depicting the ship's being overturned by the wave – the only exterior set constructed was a 20-foot section of deck and railing. Surrounded by bluescreen, the partial deck set was used for a scene in which passenger Richard Nelson (Richard Dreyfuss) abandons the New Year's Eve revelry in the grand ballroom to contemplate suicide.

refracting the light properly.” In the end, 1,200 CG lights illuminated the boat in full exterior shots, with many more ‘glows’ added in composites.

The nighttime ship required even more detail than its daylight counterpart, especially after the roll, when all of the surfaces were wet and reflective. “In the daytime shots,” stated Pat Conran, “the sun completely blew out the white ship, and we’d lose all the detail. But when we got to the nighttime ship, detail became much more crucial. We had to see the paneling on the side of the ship, the grooves between the wood floor — everything. We had to go in and dress those shots very thoroughly to make them look good.”

For views of ship interiors as seen from outside the vessel — such as the bridge and cabins — ILM deviated from its mental ray and Zeno software pipeline, and turned to art director Wilson Tang and his crew to generate them using an image-based approach. “The production had built a bridge set on stage,” Kim Libreri explained. “We photographed that and used image-based rendering to generate textures so that our CG bridge looked exactly like the set. That worked so well, we decided to treat all of the interiors as synthetic image-based captures. Wilson and the art department made their own dressings for the interiors, adding televisions, curtains, beds and other furniture. And they did this using purely off-the-shelf software. That took a bit of strain off of Philippe Rebours and CG supervisor Kevin Sprout in terms of rendering the boat — and the interiors looked great.”



In three shots for the sequence, ILM extended the small piece of live-action footage filmed on the minimal deck set, surrounding it with computer generated ship, ocean and a moonlit sky. Whereas sunlight tended to blow out the vessel's white exterior in daytime views, the lighting in close- and mid-range nighttime shots laid bare every modeled plank, deck chair and rivet, requiring far more detailed set dressing.

Poseidon opens with an extremely ambitious, lengthy and complex title shot that starts with the camera in an underwater environment, beneath the ocean's surface. The calm ocean depths are then disturbed by the huge black silhouette of the Poseidon's hull passing through frame. The shot continues with the camera rising out of the water and circling high overhead to reveal the full majesty of the ship. The camera then picks up a man, Dylan Johns (Josh Lucas), jogging on the promenade deck, and tracks closely with him for a moment before again rising upward.

This sweeping 4,329-frame, three-minute-long establishing shot of the Poseidon at sea was entirely computer generated, with the exception of greenscreen footage of Josh Lucas shot via a CableCam rig at Sepulveda Dam. “We needed a very wide open space to shoot this,” noted Kim Libreri, “because the whole move has more than 400 feet of camera travel. Sepulveda Dam gave us the space we needed. Because of the complex choreography of the camera move, it was an extremely complicated setup, shot in two pieces. The first piece was the part where we sweep past Josh Lucas; and the second was when we come back to him at the end of the shot — after spending more than 4,000 frames circling high around the boat — and the camera closes in to within a couple of feet of his face. Working out the choreography of that, and making sure we didn't hit Josh Lucas with the camera, was very complicated.” The CableCam setup at Sepulveda Dam consisted of four 120-foot-tall towers, with cables, defining a 6,400-square-foot space. “We used the CableCam rig to re-create

our virtual move around the ship, so that we could actually catch up with the real Josh Lucas, in the correct lighting situation.” ILM matchmover Colin Benoit designed the previz used to program the CableCam rig.

ILM integrated the CableCam footage with its fully digital ship, ocean and skies. Frames in which the camera is circling high overhead also featured a digital double for Josh Lucas, as well as generic digital characters walking on deck. “Obviously, an empty boat in daytime would look like a ghost ship,” commented Pat Conran, “and so we had to add people to it, even though they were very small in frame. The ship had 75 different digital doubles on it, many of them ILM crew people. Philippe Rebours and his wife and baby are on the deck of the ship. Melissa Lin — who rendered the digital doubles — and others are sitting in lounge chairs, sunbathing.” Boyd Shermis and Rhonda Gunner are also present in the shot, sitting at a deck table at the ship’s bow.

All of the digital doubles were created from 3D cyberscans executed by Eyetronics, which scanned up to 100 people a day to supply production with the necessary variety and volume of digital characters. “We have a unit that we use when we’re scanning a lot of people,” explained Eyetronics vice president of operations Nick Tesi, “which takes only a minute and a half per scan. The unit is basically a turntable that the talent stands on, holding on to poles on either side. The turntable moves very slowly, making eight stops. During each of those stops, our system takes about 12 pictures, utilizing different types of light to capture the geometry and 4K-by-4K texture maps. Our system is very fast, and it gives us really good information.”

Employing the turntable setup at their facility, Eyetronics cyberscanned large numbers of characters, ranging in age from young children to 77-year-old Sheila Allen — widow of *The Poseidon Adventure*’s producer, Irwin Allen. For scanning key actors on the set at Warner Brothers, the Eyetronics team used a portable handheld unit that, while slower, provided more accurate and higher-definition data. “It is an armature that holds a camera and two flashes,” said Tesi. “So using it is like doing a camera shoot. We can handhold it and shoot from any angle. That takes a bit longer — about fifteen minutes per character to do a full body — but it gives us the flexibility to do high-resolution shooting. And that’s what we need when we’re doing main characters that you are going to see much closer to camera, as opposed to an extra



Rather than spend unnecessary dollars and man-hours building full-scale interiors in their entirety, and with limited stage space in which to do it, Petersen, Sandell and their production crews opted to build partial ship sets that were subsequently extended digitally by the various visual effects vendors. On a partial service corridor set, Poseidon crew members take time from their duties to celebrate the beginning of the new year – unaware of the disaster about to befall them.



In the final shot, artists at CIS Hollywood tracked CG extensions to the partial service corridor set, and added digital doubles milling about in the background. For later scenes in the corridor, after the ship has been severely damaged and overturned by the wave, CIS extended an inverted version of the set. Because the inverted set had been backed with gray screen, rather than blue – to minimize reflections from lighting units and practical atmospherics – the CIS team performed extensive and painstaking rotoscoping to create a matte area for its post-roll CG corridor extensions.

who's going to be in the background." Eyetronics delivered the cyberscans to the effects vendors working on the show as Maya files. "We can deliver in any number of formats — 3ds, Lightwave, Softimage — depending on what the effects people need."

Dylan and other main characters — ex-fireman Robert Ramsey (Kurt Russell) and his daughter, Jennifer (Emmy Rossum), young mother Maggie James (Jacinda Barrett) and her son, Conor (Jimmy Bennett), stowaway Elena Gonzalez (Mia Maestro) and Richard Nelson (Richard Dreyfuss) — have been briefly introduced prior to the action's shifting to a New Year's Eve celebration in the ship's grand ballroom. Despondent over the breakup of a relationship, Nelson abandons the party to stand at the railing of the deck and contemplate suicide — until his morose thoughts are interrupted by the horrific sight of a distant, but monstrous wave thundering toward the ship.

Production shot Dreyfuss on a 20-foot section of railing and deck — the only ship exterior set built for the show — and then ILM filled the frame with the CG boat, ocean and moonlit sky. "We had to do a huge amount of CG set extension to extend the very tiny piece of set Richard Dreyfuss was standing on," Kim Libreri remarked. "We did three shots with Richard Dreyfuss and the set extensions, and then three or four shots of the approaching wave before it hits."

Originally, Wolfgang Petersen had intended to explain the origin of this massive wave in a handful of shots that would have shown its formation at sea. Toward that end, Boyd Shermis had done exhaustive research on rogue waves, a real-life scientific phenomenon that occurs when opposing ocean currents meet and join forces. "It's similar to how a magnifying glass focuses the sun's rays down to something so intense, it can set something on fire," Shermis explained. "You get that same concentration of currents and energy in water, and that is what causes a rogue wave. Satellite studies have shown that they are happening all the time. There is strong suspicion that in the last 20 years, 60 ships lost at sea were capsized by rogue waves. And there's a school of thought that the *Bermuda Triangle* phenomenon is due partly to rogue waves. We were going to have four or five shots that showed opposing currents impacting and focusing their power, just to give the audience some explanation as to where this thing comes from."

ILM had proceeded as far as creating rough animatics for the shots when Petersen cut the sequence. "It is very difficult to illustrate something as amorphous as water currents," commented Shermis. "And, ultimately, we decided we didn't need these shots. Wolfgang felt it was better to have this huge wave come out of nowhere, so that it was as much of a surprise to the audience as it was to the passengers aboard Poseidon."

ILM created the approaching wave as a moving wall of geometry, with combinations of foam generation algorithms and particle systems forming the whitewater crest at the top. The height of that wall of water — markedly taller than real-world rogue waves — was determined by the height of the boat. "When the wave hit," explained Kim Libreri, "the production wanted the contact point to be the top decks of the boat. They felt that if the wave didn't hit the top deck, there wouldn't be enough energy to roll the ship over. That required that the wave reach a height of 200 feet. But, shot by shot, the size was pretty much an aesthetic determination. In some shots, the wave is actually 400 or 500 feet high — that's movie magic for you!"

Maintaining a sense of scale, shot by shot, was one of the challenges of the sequence. Adhering to the long-established cinematic rule — ‘big things move slowly’ — ILM CG supervisor Henry Preston and his team generated a relatively slow-moving wave, both in terms of its approach and its internal movement. “We have bits of foam that travel up the wave and hit the top of it,” explained Libreri, “and then peel away. To suggest how massive this wave was, we timed the dynamics so that it took any given piece of foam a very long time to make that trip. We also put a bit of atmosphere in the scene to give you some depth cues. All of those little dynamics and atmospheric were visual cues to the size and scale of this thing.”

ILM produced a dozen subsequent shots of the wave breaking on the ship, rolling it 180 degrees. “It’s like a wipeout on a surfboard,” said Jeff Olson, “except this ‘surfboard’ is a boat that is 1,200 feet long! Eventually, the boat tips all the way over; and then we go underwater and see all of this debris and deck furniture and bodies rushing toward us.”

Unlike the approaching wall of water, the highly dynamic and interactive breaking shots required full-on computational fluid dynamics — the most sophisticated ever applied to film production, and far beyond what ILM had developed for *The Perfect Storm*. “On *Perfect Storm*,” Boyd Shermis noted, “they created a surface tension that the boat was riding on. Any time a wave hit the boat or the boat hit the wave, they simply generated a particle stream to simulate whitewater, and slapped that on top of the surface tension. When you look at it today, it’s almost painfully obvious that’s what they did — not that they didn’t do a good job. Their work was amazing for its time; but it was nothing close to a full 3D, volumetric fluid simulation.”

Though fluid dynamics technology had matured since *Perfect Storm*, it had never been used to create water simulations of this scale. Demonstrations of fluid simulations, such as those presented at Siggraph, most often involved water splashing around in a teacup. “If you were lucky,” said Kim Libreri, “you might see a simulation involving something as big as a bathtub — but never something of this scale. We needed a ton of resolution to make this work. Arriving at that was a long and difficult process that took months and the collaboration of many people.”

Key among those people were members of Professor Ron Fedkiw’s hydrodynamics team at Stanford University, a group with which ILM had been collaborating on fluid simulations for some time. Prior to the *Poseidon* production, the Stanford group had developed a fluid dynamics engine called PLS — ‘particle level set’ — which ILM had used on *Terminator 3* to generate the look of liquid chrome, and on the latest *Harry Potter* film to create shots of a ship rising out of water. PLS produced fluid simulations that not only accurately represented the surface of water, but also all of the internal dynamics — such as spray, foam and bubbles — that would be seen as the wave broke on the ship. “We wanted a simulation that would spread a 3D volume of water out into a billion particles when the wave broke or water impacted the boat,” stated Shermis, “just like real water does when something hits it. We wanted spray and foam and whitewater that were actually born from the 3D volume of water, rather than just slapped on top of a water surface.”

While Stanford’s PLS engine could produce such dynamics in smaller-scale simulations, its efficacy for simulating a massive, high-resolution water event — literally millions of gallons of water interacting with a 1,100-foot-long cruise ship — was unproven. “When we started on this show,” observed Mohen Leo, “that technology was still very cutting-edge. All of us felt that it would be

extremely hard to get it to the point where we needed it; but we also realized that the basic groundwork was there. So we decided to move forward and use this fluid dynamics simulation technology as the main technique for our CG water.”

ILM fluid simulation engineer Nick Rasmussen helped to integrate Stanford’s fluid solver into ILM’s proprietary software package, Zeno, and added functionality throughout the production schedule to allow the artists to achieve the various water characteristics different shots required. ILM software development lead Dan Piponi developed a new proprietary interface for RenderMan that allowed ILM to render hundreds of millions of particles with multiple scattering to achieve the complex look of illuminated, splashing whitewater.

Some of the problems that had to be overcome were logistical. To get a resolution that was high enough to simulate huge amounts of water for a 100-frame shot, for example, required excruciatingly long computation times. “It would take several days to run a single take of the simulation,” Leo said. “That was just too slow for movie production.”

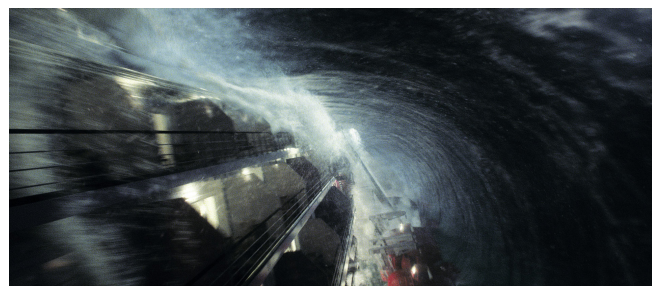
In part, the sequential, progressive nature of a fluid simulation, which required that it be run on a single processor, accounted for those slow computation times. “We’ve never been able to run a water simulation on multiple computers,” Boyd Shermis said, “because every frame has to know what happens on the frame before it and after it. It is progressive in nature; and so you can’t expect Computer 1 to calculate Frame 1, and Computer 2 to calculate Frame 2, and so on. Instead, we’ve always had to serialize it, with one computer running all 100 frames of a simulation — no matter how long it took. In this case, the simulations could take weeks, quite literally, because they were massive.”

ILM challenged the Stanford team to devise a way to run the simulation on multiple processors, and thus significantly shorten run times. Rather than divide the simulation and assign different processors specific frames, the team’s solution was to break up the simulation into sub-volumes. “We had a bunch of processors — usually between eight and sixteen — that we dedicated to a particular solve,” stated Kim Libreri. “Each of those processors was running the simulation from Frame 1 to Frame 100 — but each had only a small section of the overall volume of water to deal with. They all started at Frame 1, and each one picked a volumetric piece of the water. Once all the processors were done with their part of that frame, they communicated with one another through the network and moved on to Frame 2 — and so on. It was a cumulative, parallel process. And that made a huge difference in our run times. We went from a week to turn around a low-resolution simulation to overnight for a medium-resolution sim, and four days for an extremely high resolution simulation.”



A massive wave approaches the Poseidon. ILM created the rogue wave as a moving wall of CG geometry, with combinations of foam generation algorithms and particle systems forming the whitewater crest. Larger than a typical rogue wave – a real-world scientific phenomenon thought to be responsible for many ships lost at sea – the movie’s monster wave measured 200 feet tall, a height dictated by the size of the vessel it was to overturn. For dramatic effect, ILM increased the wave’s height to as much as 500 feet in some shots.

Rendering the computationally heavy simulation shots, too, was cumbersome, requiring that the renders be split into separate passes. “The ambient environment would be one pass,” related Libreri, “the keylights would be another, and so on. We had close to 100 layers of elements going into some of these shots, as well.” In underwater shots of the ship during the ‘wipeout’ roll sequence, ILM utilized subsurface scattering to illuminate the underwater environment. “The boat has all of its running lights on during this whole sequence, and the water had to transmit that light and scatter it. We wrote tons of subsurface scattering algorithms to get our particles and volumetrics to scatter light. I think we’re one of the first companies to do that at such a large scale; and it pays off. The water really looks as if it is being illuminated by the ship.”



Shots of the wave breaking on the ship, capsizing it and rolling it over, required highly sophisticated computational fluid dynamics. ILM teamed with the hydrodynamics group at Stanford University to develop a volumetric fluid dynamics engine that would simulate, at very high resolution, millions of gallons of water interacting with an 1,100-foot-long ocean liner, producing photorealistic spray and foam. To solve the problem of weeks-long computations, the Stanford team also devised a methodology for running the massive simulation on multiple processors.

Final refinements to the water shots — such as the addition of haze, light attenuation and motion blur — were accomplished in the composite. “We used a motion blur compositing tool call Mo,” said Libreri, “which allowed us to do 3D motion blur. By doing these final tweaks in the composite, we had a lot more fine control of the shots. We could make little changes that Wolfgang or Boyd asked for, fairly easily. That raised the shots to a higher level than they would have been if it had just been a matter of putting together CG renders.”

Rolling ship action cuts from ILM’s exterior views to interiors, where panicked passengers slide, fall and tumble as rooms begin to rotate. Rolling interior shots employed a combination of partial live-action sets attached to a 30-by-35-foot gimbal rig — engineered by special effects supervisor John Frazier — and CG set extensions peopled with digi-tal doubles.

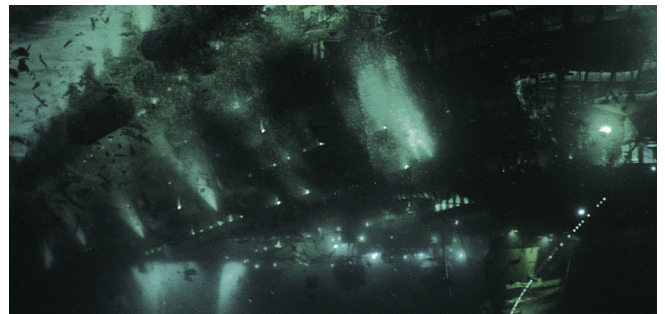
The task of extending the partial sets digitally — work that made up most of the shot counts at The Moving Picture Company, CIS Hollywood and Giant Killer Robots — was complicated by the volume of smoke, sparks and other atmospherics present in the live-action foregrounds throughout the roll and post-roll sequences. “John Seale, the director of photography, wanted to shoot the entire movie with some atmosphere,” explained Boyd Shermis. “I’ve never been one to tie a DP’s hands; and so there was always some texture in the air in the foregrounds — but not so much that I couldn’t pull decent mattes or do 3D set extensions or matte paintings. We compromised. In some cases, they shot with steam or nitrogen or sparks. If it was really problematic, I asked them not to; and then we compensated for that by shooting a couple of days’ worth of elements. Then, in post, we augmented those practical elements with a lot of CG steam, sparks, fire, smoke — you name it.”

The grand ballroom — where the New Year’s Eve party is in progress — is the setting for many of the interior roll-sequence shots. “We wanted to see this 150-foot-long room full of tables and 200-plus people roll over,” said Shermis. “Of course, we couldn’t roll a room that big on a gimbal. So we built small sections of that set, put those on gimbals, and rolled them over.”

The gimbaled sets were surrounded by bluescreen dotted with markers to aid Moving Picture Company in tracking its CG set extensions. “We pretty much had to build the entire ballroom environment in CG,” recalled MPC visual effects supervisor Chas Jarrett, “because the gimbal rig didn’t give us very much to start with. We’d have a couple of principal actors in the foreground, with a few props flying by — but that’s it. A lot of these were really wide-lens shots looking at the whole room; and everything in those shots was CG.”

Unfortunately, by the time MPC came on the show, production had finished shooting its grand ballroom sequences, and had already started to strike the set, eliminating any opportunity for Jarrett’s team to photograph the environment under the appropriate lighting. The on-set MPC crew compensated by shooting digital stills or video of every texture, every piece of furniture and every prop on the set. The crewmembers also gathered from the production art and construction departments samples of materials used to build the set, which they scanned when they returned to their facility in England.

The detailed level of set dressing in the grand ballroom made for an extensive and painstaking modeling task for MPC. “The room was packed with people and tables and chairs and glassware,” said Jarrett. “All the tables had food on them. There were decorations all over the room — confetti and streamers and balloons everywhere. On top of that, there was a casino on the balcony surrounding the ballroom, so we had to model everything that goes with a casino: playing cards and chips, different types of tables and chairs and stools. We spent four or five months just modeling and texturing everything, creating a huge library of models.”



Once everything was modeled, MPC employed its custom Maya plug-in, Papi, to create dynamic movement and interaction between objects during the roll. “All of the tables and chairs — and even some of the characters — were simulated using that system,” said Jarrett. “It’s a very fast and powerful tool; and without it, we couldn’t have simulated the staggering volume of stuff that we had in these shots. We used Papi to make things like playing cards, confetti, streamers, balloons, tables and chairs move. We had a lot of cloth simulation for the tablecloths and curtains, as well. It was a scale of simulation we’d never done before. These shots had 100,000 objects or more in a scene, all moving dynamically.”

MPC employed its proprietary crowd simulation software, Alice, for the majority of the character sims, needed for shots of digital characters tumbling, being hit by objects, and generally reacting appropriately to the chaos around them. “We conducted motion capture sessions here in the U.K. with some stunt people,” explained Jarrett. “And through that, we got a huge library of motions for the passengers during the roll — people hanging from things, running into tables and each other, rolling on the ground, all of them trying to grab things or stop themselves from sliding. There had to be a real sense of life to these actors — and there were so many of them. We did shots of 30 or so Oompa Loompas in *Charlie and the Chocolate Factory*; here, we had 200 people in a shot!”

Rather than attempt to construct 200 individual characters, MPC modeled a variety of body shapes and sizes, and then mixed and matched them with different items of clothing to build up an adequately varied crowd. “We found that just by putting a different cardigan or shawl on this dress or that dress, we could get a huge perceived variety,” related Jarrett, “even though we hadn’t modeled and textured that many characters. We used a lot of shaders, which randomly altered the texture maps that we’d painted — changing the hue a little bit, or making one more shiny and another more matte — and that created a lot of variety, as well.”

MPC ran both character and rigid body simulations in stages, starting with the larger objects, such as tables and chairs, and then adding in characters impacting and interacting with those larger items. “Once we had the gross movement of those big objects,” Jarrett said, “we’d add in all the



Exterior shots of the rolling ship are intercut with interiors, such as the crowded grand ballroom, where the on-board New Year's Eve celebration is in full swing. To capture foreground rolling action, the production built sections of the expansive ballroom as gimbaled sets, and peopled them with small numbers of extras. The gimbaled partial sets were surrounded by bluescreen dotted with markers to aid The Moving Picture Company in tracking CG set extensions.



Because the live-action filled only a part of the frame, MPC was required to build the entire ballroom in CG. An on-set MPC crew shot digital stills or video of every set structure and prop, and also scanned samples of materials used to build the set. Over a period of five months, MPC modeled and textured a vast library of tables, chairs, glassware, plates of food, confetti, streamers, casino chips and playing cards, as well as digital doubles, then used its custom Maya plug-in, Papi, to simulate dynamic movement and interplay between CG people and objects during the ship's rollover.

small things like poker chips, balloons, playing cards and glasses, simulating those separately to interact with the large objects. If we'd tried to simulate everything in one big go, it would have been too complicated."

Throughout the roll sequence, the action cuts from the grand ballroom to other areas of the cruise ship, such as the galley. CIS Hollywood extended a partial galley set that John Frazier had mounted to a gimbal to capture foreground rolling shots. "We ran some rigid body dynamics to get debris flying around the galley," explained CIS visual effects supervisor Bryan Hirota. "We also added digital chefs and other characters tumbling about, using Massive and scans of the actors playing the chefs and waiters to populate the background of our CG galley set. We blended some of our Massive stuff with keyframe animation, and we also played around a little with endorphin." Endorphin is a relatively new human dynamics simulation from NaturalMotion. "Using endorphin, we could put a character in a scene and start to roll the room, and that character would behave in a realistic way, stumbling and falling and trying to grasp at things."

Giant Killer Robots also employed endorphin to simulate 75 panicking people in its 15 roll-sequence shots set in the ship's nightclub — another minimal live-action set that was tracked and extended digitally. "Endorphin is a fantastic piece of software," stated GKR visual effects supervisor Mike Schmitt. "Just like a rigid body simulation allows you to simulate hard-body objects running into one another, endorphin allows you to do that same motion and interaction with human beings. It's tailored toward human-shaped bipeds; but you can also do hard-body simulations in it. We ended up doing some keyframe animation on the closeup people; but, even so, endorphin was a great head start." Since the version of endorphin they were using was able to simulate only between 10 to 20 people at a time, GKR built up the simulated crowd and furniture in layers. "When you start putting tables and chairs and other obstacles in there, it adds up really quickly. So we came up with a way to do it pieces at a time, making sure that people and objects were running into things as they should be in the overlapping areas."

In one shot in the nightclub scene, a large light-ing truss falls from the ceiling onto the crowd, rolling people over like bowling pins. "What they had shot on set was a tilting platform with a giant blue bar on two tracks that could slide and knock over stunt people," recalled Schmitt. "So in the foreground we had these real people being knocked over by this padded bar, with large gaping holes in the action to the sides and back of frame. We replaced the padded bar with a CG truss falling from above and wiping through these people. Then, in the foreground and the background, we added our 75 digital doubles, tables, chairs and party streamers, all knocking around and falling over one another."

At one point in the sequence, the action cuts to the ship's engine room. Although a miniature engine room was built and shot for a later sequence, these roll shots were all-CG views, created by Hydraulx. "We couldn't use any photography of the miniature for these shots," stated Hydraulx co-founder and visual effects supervisor Colin Strause, "because that miniature represented the engine room after it has



After the roll, a small group of passengers led by Dylan and ex-fireman Robert Ramsey (Kurt Russell), opts to

been damaged. So we took lidar data of the miniature, and rebuilt a less-damaged engine room in Maya. We put a few 3D stunt actors in there, as well, hitting railings, sliding down decks, flipping over. We added a lot of sparks and explosions. We animated bigger things like pipes bending and breaking; but, for the smaller things — like tools and nuts and bolts flying out of opened tool bins, or little lights breaking, or small pieces of glass raining down from the top — we ran rigid body simulations.”

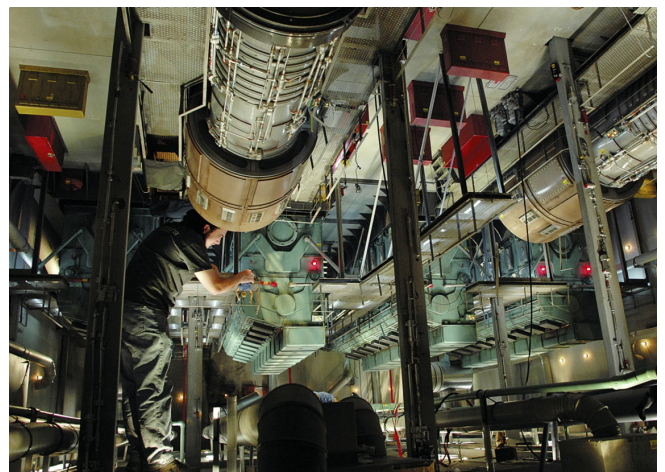
ignore orders from the captain to remain in the ballroom and attempts an escape through the up-ended hull. When their route is blocked by fire, they must cross an 18-story elevator shaft on a precarious, makeshift bridge. Giant Killer Robots artists extended a minimal set, modeling the entire elevator shaft in 3D to accommodate multiple camera angles. GKR also created a digital double for a crewmember who falls to his death in the shaft.

After the roll sequence, the severely damaged Poseidon bobs upside-down in the ocean, its hull topside, and its upper decks below the surface of the water. Ignoring instructions to remain inside the sealed ballroom, Dylan and a small group of other surviving passengers attempt to escape by climbing upward, into the bowels of the ship, facing fires, floods, explosions and other dangers along the way. Their escape route leads them first to the galley, where fires ignited from leaking gas pipes prevent their passage.

To facilitate CIS Hollywood’s CG set extensions, the partial galley set shot on stage at Warner Brothers had to be surrounded by a process screen; but Boyd Shermis decided against bluescreen, due to the highly-reflective nature of the set, which featured large areas of stainless steel. “There would have been a lot of blue reflections and contamination if we had gone with traditional bluescreen,” Shermis explained. “Instead, I pulled something old out of my bag of tricks, and thought of using retro-reflective screens, which give you a columnated light that doesn’t bounce or reflect off of anything. You shoot low-level light at it, and it reflects light back at the lens on exactly the same axis. It doesn’t spread light, randomly, in all directions; and that was just what we needed for this very reflective galley environment.” Unfortunately, due to the waning of front projection techniques, no one had used a retro-reflective screen in feature film production for some 15 years. “I wasn’t even sure anyone would have one of these things; and I had to call a lot of the old-school players before we finally found one that was in good enough repair and big enough to cover our set.”

In addition to digitally extending the galley for the scene, CIS Hollywood added fires, explosions, dead bodies and CG water to create the illusion of flooding. “The galley sequence was really difficult,” stated Bryan Hirota, “because there were so many big, fiery, explosive events. We used a library of elements to enhance those shots and create explosions.”

Unable to move forward through the galley, the survivors must cross an 18-story elevator shaft on a makeshift bridge they’ve rigged by resting a metal table on a thin ledge. Giant Killer Robots extended a



For shots of the Poseidon’s inverted engine room – which would figure prominently in an explosion sequence at the

partial elevator shaft set and created 3D elements, based on action prevized by Frantic Films. “The length of the elevator shaft was actually cheated from shot to shot to accentuate the sense of danger,” admitted Mike Schmitt. “We see that shaft from every angle you can think of: from the bottom, looking up; from above, looking down; from the side.

film’s climax – Mike Joyce and his Cinema Production Services team built a 1/6-scale miniature, photographed on its stage by consulting visual effects supervisor Greg McMurry. To track the camera through the confined miniature, McMurry shot the engine room set in multiple motion control passes, removing obstructing set pieces with each successive pass. CPS painter Eric Hayden touches up the miniature prior to filming.

So we created the entire elevator shaft in 3D. We had to get very creative with our matchmoving to match the live-action set to our CG set. There was a lot of seaming in between the two, lining up architecture, color, atmosphere, and so on. In some cases, it was easier to completely replace the live-action set with our CG set.” GKR also created a digital double for shots of one of the characters falling to his death.

The sequence terminates with an elevator car in the shaft above the characters finally breaking free, exploding upon impact down below. “This falling elevator just misses the characters as they get across the bridge,” remarked Schmitt, “and then there’s a huge explosion. We did that explosion as a computer generated effect, and layered in CG smoke and practical fire elements from our library to augment it. We also built the falling elevator in 3D, and animated buckling walls and falling debris.”

The survivors must execute another harrowing crossing when they arrive at the precipice of the ship’s inverted grand lobby. The characters traverse the eight-story chasm by walking on a mangled ‘bridge’ comprised of a detached elevator car and support rigs. “It is perilous below, as they try to cross without plunging to their deaths,” Boyd Shermis explained. “It is also perilous from above, because there is a damaged air conditioning unit dangling precariously over them.” Roiling, bubbling water floods the lobby, the water level quickly rising as the characters cross the makeshift bridge. Production staged some of the action on an inverted, four-story lobby set, constructed on the tank stage at Warner Brothers. “Ironically, we didn’t end up shooting much of the upside-down lobby with water, because we wanted to extend the water far beyond the level it would reach in the tank. So we filmed it in the tank, dry, and then we added CG water.”

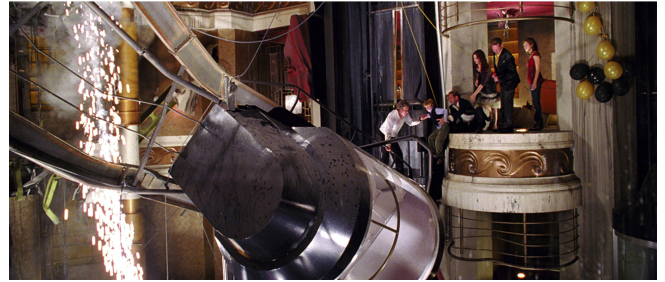
The Moving Picture Company photographed and documented the partial inverted lobby set, down to the smallest detail, and used lidar data to extend it to a full 360-degree, eight-story CG set. MPC also added the falling 3D air conditioning unit and flooded the lower levels with CG water and other elements, using new simulation software. “After the A/C unit above them tears away,” stated Shermis, “a column of fuel oil pours out of the new hole in the ceiling and falls into the water below. Both the column of oil and the water are 3D.” That cascading oil then ignites, creating a fire. “We decided early on that we couldn’t just fill our tank with water and then dump oil into it — because, of course, that would be hazardous. And it would have been even more hazardous to ignite this interior set and fill it with smoke and fire. Since we couldn’t do any of it practically, MPC had to find a way to create CG oil falling into CG water, igniting and producing CG fire and smoke.”

“This sequence had all three of the ‘Holy Grails’ of 3D work,” said Chas Jarrett, “water, fire and smoke. And, all three of them had to interact.” The solution to the problem of how to achieve interacting water, fire and smoke in a 3D simulation came from Scanline, a German visual effects firm which had developed an advanced fluid simulation software called Flowline. MPC had become aware of the company at Siggraph years earlier, and had been intrigued by its commitment to high-level research and development. “Just as this show came up, one of our guys learned that Scanline had this Flowline software. So we went to visit them in Germany. They showed us their demo reel of what Flowline could do, and we saw immediately that it was unlike any other approach to fluid simulation. Rather than a pure math and science fluid simulator, Flowline was more about how to get stuff to look really cool. It had certain imaginative and clever ways of getting around problems, which made it much more manageable, computationally; but it still created incredible levels of detail. It was the ideal tool to be used for visual effects.”

Flowline was also advantageous in that it could produce fire and other gaseous effects. “Flowline created the best CG fire I’d ever seen,” commented Jarrett. “Using Flowline, we could produce fire, smoke, water and steam — any of those types of effects. And we could simulate those things and their physical interaction, all within this one

software. The idea of simulating different viscosities of liquid and gases together was quite exciting for us because, to our knowledge, that had never been done for a film before. For Poseidon, the ability to mix the different mediums in one sim and make them all cohesive was fundamental.”

MPC formed a partnership with Scanline, working with Stephan Trojansky to retool Flowline so that it would work with Maya and on the Linux platform — the basis of MPC’s pipeline. “Stephan and Scanline retooled the software at their Munich-based studio to meet our needs for the show, using the core code and technology they’d already developed,” said Jarrett. “Then, Stephan and key Scanline staff played a key role in technically directing simulation shots during a two-month placement at MPC. Their contribution was fundamental in the creation of incredibly believable CG fluids.”



The survivors climb atop a damaged elevator car to traverse the eight-story chasm of the inverted grand lobby, as rising flood waters threaten them from below. Production staged live-action for the scene on a four-story, inverted lobby set, built on the tank stage at Warner Brothers. However, since the tank was not deep enough to hold sufficient depths of practical water, Shermis and Petersen shot the set dry, then engaged Moving Picture Company to incorporate CG water effects in postproduction.



For wide shots, MPC also extended the pie-shaped, four-story set to a full 360-degree, eight-story lobby, modeling its CG geometry from photographic documentation and lidar data. Digital artists at MPC employed an innovative simulation software called Flowline – developed by Scanline, a German visual effects company – which enabled them to create dynamically interacting fire, water and smoke within a single simulation.

As they continue their perilous journey through the labyrinthine ship, the characters attempt to exit through the 'broadway' corridor — a service corridor featured throughout the movie — only to find it flooded and impenetrable. "The idea is that this service corridor runs the entire length of the ship," explained Shermis, "but, of course, we didn't build a 1,100-foot corridor set. We just built 110 feet of it; and then CIS extended it." To create a matte area for the digital set extensions, the partial corridor set had to be backed by some sort of a process screen; but, partly due to practical atmospherics present on the set, bluescreen, again, was unsuitable. "These shots had water, smoke, steam and fire, making them worst-case scenarios for bluescreen, because of all the reflections. That left us with only a handful of options, one of which was using a 'gray screen' — and that's what we did. It didn't give us a perfect matte like we'd get with a bluescreen; but it did give us a good outline from which the artists could rotoscope a very accurate matte."

For pre-roll scenes, CIS extended the Broadway corridor in its right-side-up configuration, adding digital doubles milling about in the background. For the roll sequence, CIS extended a partial gimbal set, and used its rigid body and human dynamics simulations to create pushcarts and other objects, plus people falling and tumbling in the corridor. CIS also added CG fire and sparks to the roll-sequence shots.

The post-roll scene in which the characters try to make their way through the flooded corridor required CIS to extend a partial set that was angled and filled with real water, and to create a wall of CG water that rushes through the corridor and engulfs Maggie after an explosion in the engine room causes the ship to shift. "We used RealFlow to do the main simulation of the water," explained Bryan Hirota. "We wrote our own internal mesher to turn the simulation into geometry, and rendered it in RenderMan using ray tracing and subsurface scattering. We did two big all-CG shots for the rushing water sequence; and those shots meet up with a couple of live-action dump-tank shots that were done in a couple of passes — the actress without the water and the water by itself. We had to blend those passes together and add CG debris to make the dump-tank water look more dangerous."

ILM created exterior views of the massive engine room explosion that releases the rush of water in the Broadway corridor, while miniature photography provided interior views. Consulting visual effects supervisor Greg McMurry shot an engine room miniature that was constructed by Mike Joyce and his Cinema Production Services crew, using animatics created by Proof. "There were actually two parts to the miniature," McMurry remarked. "There was an engine room that they built at 1/6 scale, measuring about 30 feet long, and a quarter-scale miniature representing the adjacent control room."

The miniatures were shot motion control, in multiple passes, to accommodate the different shooting speeds required by the two different scales. "We had to shoot it in sections, just to get the camera rig through the walls of the rooms," related McMurry. "The shot starts with the camera moving up to a door in a hallway, where there is a little porthole window. We shot a pass where we got up as



close as we could to the window; then we backed up, took the door off, and moved in a little further. The camera couldn't fit inside the quarter-scale room, either, so we had to take out the ceiling — which was really the floor — one piece at a time to get the camera further and further into the room. Once we got up to the big window that looks from the control room into the engine room, we had to remove it to continue moving forward. Finally, we did a pass with the explosion, which we filmed at high-speed.”

After exiting the ship and making their way to a life raft floating nearby, the survivors are nearly crushed as the Poseidon upends and does a final death roll before sinking. Shots of the actors inside the raft, desperately rowing away from the rolling ship, were captured on the water tank stage at Warner Brothers. For wider shots of the characters riding out small tidal waves created by the ship's final descent into the depths, ILM replaced the live actors with digital doubles in a CG life raft amidst fluid dynamic waves.

The in-camera miniature explosion, orchestrated by pyrotechnic effects supervisor John Stirber, had multiple ignition points to create a sequential effect. “I wanted it to look like a chain reaction,” explained McMurry. “We had a timing circuit that was triggered from the motion control; and there were other events timed to it, as well, such as pipes breaking away and fire hoses flopping around. The engine panels were made out of a resin material that exploded and broke apart and shattered like glass. After we blew the set, we shot a couple of bigger fireball explosions, just to give them some elements they could add in. It was a lot of fun to do an entirely in-camera move and explosion on a miniature — which is something we don't get to do much anymore. It reminded me of the way we shot this kind of thing 20 years ago!”

Hydraulx composited the multiple passes of the miniature photography and added small digital enhancements, such as gasoline running down pipes and oil dripping out of turbines. “We did fluid simulations, using RealFlow, for the puddles of fuel and gasoline,” remarked Hydraulx co-founder and visual effects supervisor Greg Strause, “and we also added in steam and sparks — a lot of things they didn't want to do in-camera because they would have destroyed the scale. From lidar data of the miniature, we rebuilt a fully detailed engine room in Maya, and used that for all of the particle collisions and to do the actual fluid simulations for liquid dripping down and pooling up on the ground.”

The survivors finally make their way to the bottom — now top — of the ship, where they hope to exit through giant thruster tubes. Spinning propellers within the tubes create a violent, tornado-like vortex — a computer generated effect realized by CIS — preventing their escape. “These propellers create a vortex of debris and water and wind that is so powerful,” said Bryan Hirota, “it throws Josh Lucas' character up against the wall of the tube. All they had shot on the set was the actors with some fans blowing a little bit of debris around. It wasn't nearly dynamic enough, and there wasn't nearly enough debris; but it was a starting point, and it created some sense of mayhem on the set. We used our particle simulation to add in volumetric water elements and general debris spinning and being sucked out the hole in the tube. We also removed big hanging chains that were on the set and replaced them with CG chains to make it appear as if they were being sucked into the hole, as well.”

Robert Ramsey swims underwater to the submerged thruster controls, reversing the direction of the propellers so that his fellow passengers can lodge a foreign object into the blades and stop their spinning. The characters finally emerge out of the thruster tubes and onto the upended exterior of

the ship, 30 feet above the ocean's surface. Production shot the actors on a thruster tube set, backed with bluescreen; and then ILM added CG skies and ocean to fill out the live-action photography. "We also put in some atmospherics," stated Kim Libreri, "because the propeller had just exploded and there was smoke and residue in the tubes. Then the camera pulls back, and we see the whole boat upside down, surrounded by turbulent bubbling water churned up as the boat continues to sink. The pullback starts on the thruster tube set piece with the actual principal actors; and eventually it pulls back into a very wide shot where we see the whole CG boat and CG ocean."

The survivors make the high-jump into the water and swim to a life raft floating nearby. Their sense of safety once inside the raft is jeopardized when the Poseidon, in its final death throes, begins to roll over, threatening to crush them. Shots of the actors inside the raft, desperately attempting to row away from the rolling ship, were captured on the water tank stage at Warner Brothers. For wider shots of the life raft and characters riding out small tidal waves created by the ship's motion, ILM replaced the live actors with digital doubles, and surrounded a CG raft with fluid dynamics waves.

ILM referenced a National Geographic program, titled "Cruise Ship Rescue," for subsequent shots of the Poseidon sinking. "That television program showed a cruise ship going down in a matter of minutes," said Kim Libreri. "From that reference, we could see that the ocean became extremely turbulent, with lots of debris in the water; and that was the look we were going for in this sequence. Because we had this great fluid simulation from Stanford, when we capsized our boat and threw it underwater, the water reacted properly to that event. And then you see the Poseidon disappear into the murk, all of its lights finally going out, as if it has finally died."

As dawn breaks on the morning after the disaster, helicopters arrive to rescue the few surviving passengers of the lost Poseidon. "There's a big pullback shot that they roll the end credits on," said Libreri. "It has CG helicopters, CG life raft, CG water, CG skies — everything. There are live people in the raft at the very beginning of the shot; but even they become 3D as the camera pulls back."

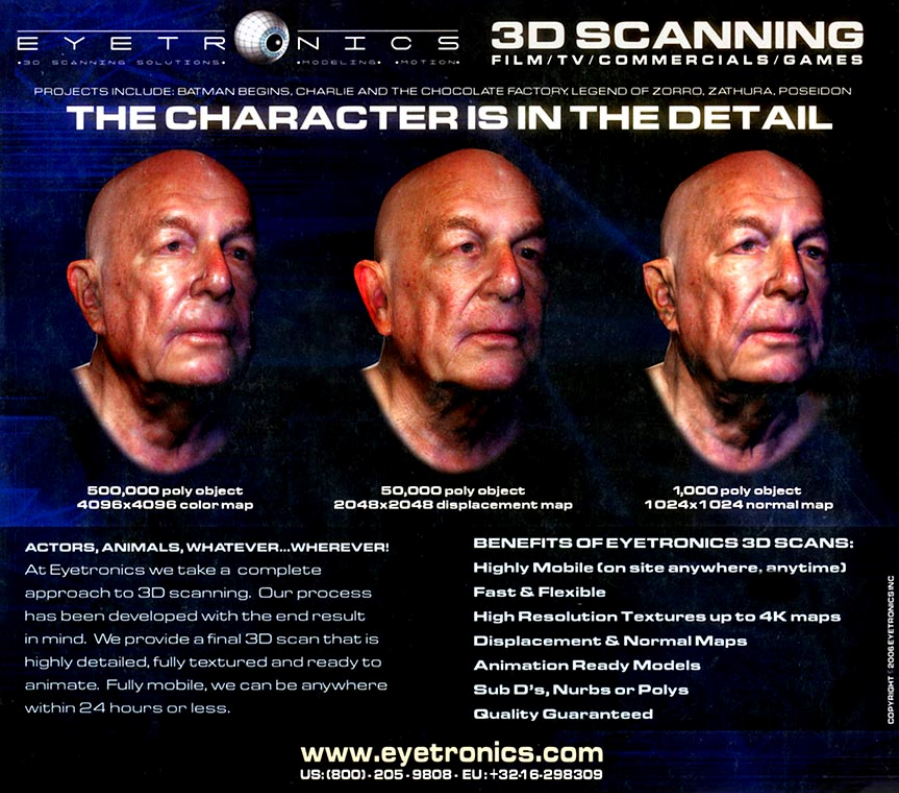
Despite Poseidon's designation as a 'remake,' there was nothing retro about its effects, many of which broke ground and records in equal measure. "According to ILM," observed Boyd Shermis, "the effects shots for Poseidon were some of the most difficult they've ever had to do, and they took up more resources on a per-shot average than any other show they've ever done. That illustrates the main point about this movie, which was that, in terms of effects, it wasn't about quantity — it was all about complexity. There weren't a million shots of the ship, for example; but the few shots we had were really, really hard."

Poseidon's level of difficulty, rather than a deterrent, actually drew Shermis and others to the project. "Doing a boat and water on this scale was very challenging," Kim Libreri asserted, "and people around here love a challenge! Many of those who had worked on Perfect Storm, especially, were eager to work on this show. Their attitude was: 'Come on — let's do it again! This time we will get the fluid dynamics to work!' At the beginning, we felt very brave about being able to do that. Halfway through the show, of course, we weren't feeling quite so brave; but, with perseverance, we got it to work. It was hard work, but it was great to climb that mountain."

If the love of a challenge was a draw for many of the visual effects artists and technicians who contributed to Poseidon, so too was lingering affection for the original movie upon which the film

was based — a film that, despite its high ‘corn’ content, remains a favorite among movie fans. “In terms of the effects, *The Poseidon Adventure* doesn’t look great by today’s standards,” said Boyd Shermis, “but a lot of people in the business still love that movie and have very fond memories of it. I’ve been surprised by how many people have confessed to me that *The Poseidon Adventure* is one of their ‘guilty pleasures.’ I think that feeling for the old movie drove a lot of people as they worked on this one. They wanted to do it justice. I hope we have.”

Poseidon photographs copyright © 2006 by Warner Brothers. All rights reserved. Production still photography by Claudette Barius. Additional photos courtesy of Cinema Production Services. Special thanks to Rhonda Gunner, Jesse Mesa, Miles Perkins, Stephen Kenneally, Megan Corbet, Sophie Trainor, Julie Orosz, Kelli Conley and Mike Joyce.



EYETRONICS 3D SCANNING
3D SCANNING SOLUTIONS • MODELING • MOTION • FILM/TV/COMMERCIALS/GAMES

PROJECTS INCLUDE: BATMAN BEGINS, CHARLIE AND THE CHOCOLATE FACTORY, LEGEND OF ZORRO, ZATHURA, POSEIDON

THE CHARACTER IS IN THE DETAIL

500,000 poly object
4096x4096 color map

50,000 poly object
2048x2048 displacement map

1,000 poly object
1024x1024 normal map

ACTORS, ANIMALS, WHATEVER...WHEREVER!
At EyetrONICS we take a complete approach to 3D scanning. Our process has been developed with the end result in mind. We provide a final 3D scan that is highly detailed, fully textured and ready to animate. Fully mobile, we can be anywhere within 24 hours or less.

BENEFITS OF EYETRONICS 3D SCANS:
Highly Mobile (on site anywhere, anytime)
Fast & Flexible
High Resolution Textures up to 4K maps
Displacement & Normal Maps
Animation Ready Models
Sub D's, Nurbs or Polys
Quality Guaranteed

www.eyetronics.com
US: (800) 205-9808 • EU: +32-16-298309

COPYRIGHT © 2006 EYETRONICS INC